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# REPORT TO THE CONGRESS



BY THE COMPTROLLER GENERAL  
OF THE UNITED STATES



## Dredging America's Waterways And Harbors--More Information Needed On Environmental And Economic Issues

Corps of Engineers (Civil Functions)  
Department of the Army  
Environmental Protection Agency

AGC00305  
AGC00024

The effects that dredging and disposing of dredged material will have on the environment have come into sharper focus within the last decade; and, the Corps of Engineers has been required by legislation, litigation, and regulations to modify its practices. In response, the Corps has undertaken a research program, and changed its dredging practices at certain locations, but at much higher costs. To date their research has been incomplete. In fact, the long-term effects of contaminated dredged material on the environment have not been determined.

Additional information should be included in the Corps' budget justifications submitted to the Congress on the costs and environmental effects of alternative disposal practices for those projects which the Environmental Protection Agency questions or objects to

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COMPTROLLER GENERAL OF THE UNITED STATES  
WASHINGTON, D.C. 20548

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To the President of the Senate and the  
Speaker of the House of Representatives

This report describes several aspects of the Corps of Engineers' dredging and dredged-material disposal practices, including costs and environmental effects, the impact of recent legislation, problems in developing criteria, and research being performed on the topic.

This review was made to identify and report to the Congress on the environmental and economic issues involved in maintaining the Nation's waterway system.

We made our review pursuant to the Budget and Accounting Act, 1921 (31 U.S.C. 53), and the Accounting and Auditing Act of 1950 (31 U.S.C. 67).

Copies of this report are being sent to the Director, Office of Management and Budget; the Secretaries of Defense and the Army; the Chief of Engineers, Corps of Engineers; and the Administrator, Environmental Protection Agency.

A handwritten signature in black ink that reads "Luther B. Stacks".

Comptroller General  
of the United States

COMPTROLLER GENERAL'S  
REPORT TO THE CONGRESS

DREDGING AMERICA'S WATERWAYS  
AND HARBORS--MORE INFORMATION  
NEEDED ON ENVIRONMENTAL AND  
ECONOMIC ISSUES  
Corps of Engineers  
Environmental Protection Agency

D I G E S T

Keeping the Nation's navigable waterway system fully functioning is vital to the Nation's commerce. To do so requires channel maintenance or dredging to remove large quantities of sediment. (See p. 1.)

Until the mid-1960s, the Army Corps of Engineers generally disposed of sediment near the dredging site, in open water, or on wetlands--usually the most economical method. Since then, concern over possible environmental damage associated with this disposal has increased. Unmanaged disposal practices

--can disrupt or harm fish and other aquatic life,

--may allow absorption of contaminants in the dredged material into the biological food chain, and

--under uncontrolled conditions, can directly destroy wetlands, which play an important part in the life cycles of wildlife.  
(See p. 5.)

Controversy developed over whether the Corps was doing enough to counter known or suspected effects on the environment from dredging and disposing of dredged material. Legislation and related litigation within the last decade have required the Corps to take additional precautions in dredging and disposing of dredged material. For example, the Corps has been required to determine how its dredging will affect the environment, consider the views of others in making its decisions, and comply with Federal guidelines. (See p. 10.)

Alternatives to traditional disposal sites--such as confined disposal areas, deep ocean water, and upland areas--may reduce or eliminate the

suspected environmental risks of traditional disposal practices. But, these alternatives generally increase Federal costs, often increase costs and responsibilities of local sponsors, and may affect the economic feasibility of some waterway projects.

As a result of the confined disposal program on the Great Lakes, for example, dredging costs are approximately 3-1/2 times more than they would be if open lake disposal methods were used. In other locations, the Corps estimates that alternative disposal methods may cost from 1 to 15 times more than traditional methods. (See p. 19.)

Because of potential harm to the environment, the levels at which concentrations of various contaminants become too high need to be identified.

With this knowledge, appropriate practices for disposing of dredged material can be selected. The Corps and the Environmental Protection Agency continue to refine disposal regulations, but cause-and-effect relationships between materials considered contaminated and significant damage, especially long-term damage, have not been determined. (See pp. 13 and 23.)

Because possible risks of traditional disposal practices were not well-defined, the River and Harbor Act of 1970 directed the Corps to research the effects of, and alternatives to, traditional disposal practices. Although not completed, preliminary results of the \$30 million research program indicate that open water disposal is not as environmentally harmful as first believed. The long-term effects, however, are still unknown. (See p. 23.)

Since a follow-on program may be necessary, the Corps should now advise the Congress how a follow-on program can be expedited to develop and obtain information not provided by the original program. (See p. 33.)

The Government's lead agency in environmental protection--the Environmental Protection Agency--has played only a limited role in the Corps' research program. Even though the current

program is almost complete, the Agency should participate in the final stages of the program by assigning staff to work full time with the Corps' researchers in interpreting research results and developing final conclusions for the program.

If a follow-on research program is conducted, the Agency should participate fully, from the beginning. The Agency's participation in the current and proposed research programs is particularly important because it is responsible for guidelines on disposal of dredged material and criteria to which the research will apply. (See p. 32.)

Until research confirms or dispels suspected environmental risks or identifies realistic alternatives to traditional dredging and disposal, the Government will be faced with basically three choices, or a combination of them, in maintaining each dredging project:

- Increasing costs by using dredging and disposal techniques which may be less damaging to the environment.
- Keeping costs down by reducing or eliminating maintenance of the less vital portions of the waterway system.
- Accepting the potential environmental risks of traditional dredging and disposal practices.

Before appropriating funds for channel maintenance projects, the Congress needs adequate information on the tradeoffs between economic and environmental values. Additional information which could help the Congress includes

- the cost of changing from current practices,
- a description of current and proposed disposal methods,
- the reasons for changing disposal methods,
- the environmental benefits expected from the changing methods, and

--continued economic feasibility of affected navigation projects if proposed changes are made. (See p. 33.)

The Corps, in coordination with the Environmental Protection Agency, should prepare and provide such information to the Congress when the Agency objects to the method or location of the Corps' disposal activities. (See p. 33.) The Army believes that only those cases should be highlighted where major cost increases occur due to environmental conditions. This, however, would not bring to the Congress' attention those cases where the Agency objected to or questioned the Corps' practices and where changes were not made and additional funds were not requested.

Army and Environmental Protection Agency officials agreed in principle with GAO's recommendations, but questioned how they would be implemented. (See pp. 33 to 35.)

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#### ABBREVIATIONS

DMRP	Dredged Material Research Program
EPA	Environmental Protection Agency
GAO	General Accounting Office
GREAT	Great River Environmental Action Team
NOAA	National Oceanic and Atmospheric Administration
USFWS	United States Fish and Wildlife Service
WES	Waterways Experiment Station

## CHAPTER 1

### PERSPECTIVE

The Nation's aquatic environment--rivers, streams, shorelines, wetlands, and lakes--is an important economic and natural resource providing such benefits as transportation, food, water supplies, and recreation. An important segment of the aquatic environment is the Nation's navigable waterways system consisting of over 25,000 miles of channels, 107 commercial harbors and ports, and 400 small boat harbors. This system plays an important role in the Nation's trade at home and abroad.

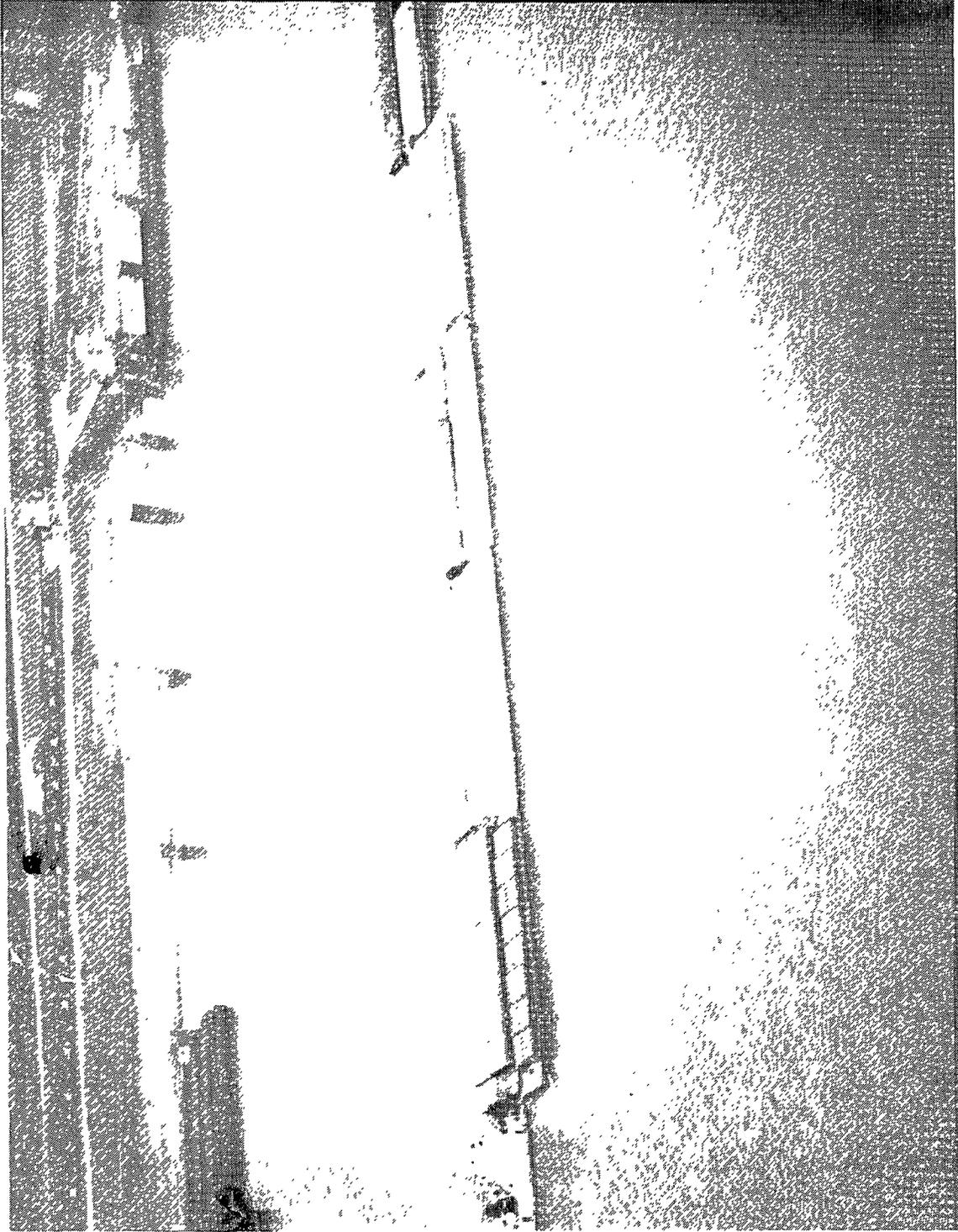
Waterborne commerce, foreign and domestic, totals about 1.7 billion tons a year. About one-third of the total originates or terminates in foreign countries. Barges and shallow-draft vessels using the inland waterways system move almost 16 percent of the Nation's domestic commerce. (See photograph on p. 2.)

Water transportation is relatively fuel-efficient, compared to other transportation modes, as shown in the following table based on information developed by the American Waterways Operators, Inc.

<u>Mode of transportation</u>	<u>Energy consumption per ton-mile</u>
	(British thermal units)
Water	500
Rail	750
Truck	2,400
Air	6,300

Since 1824, the Corps of Engineers has been responsible for planning, constructing, operating, and maintaining the inland waterways and harbors. Constructing a navigable waterway involves the removal of sediments from the bottom of the waterway (dredging) to form a channel of sufficient depth and width to accommodate barges in inland waters and ships in harbor areas, and constructing locks and dams to regulate the flow and depth of the water, as necessary, for navigation.

Reaccumulations of sediment must be periodically removed to keep channels at navigable depths. In fiscal year 1976, the Corps dredged about 287 million cubic yards of material from the waterways at a cost of about \$240 million. This is enough material to cover the entire District of Columbia (67 square miles) to a depth of 49 inches each year.



SOURCE: GAO

BARGE TOW ON THE MISSISSIPPI RIVER

Most of the dredged materials have been deposited in the water or near the water close to the dredging operation to minimize disposal costs. Moving large volumes of the material from one area of the aquatic environment to another can adversely affect the potential of that environment to serve important uses, such as food, recreation, water supply, and wildlife habitat. The danger may be increased when the material is contaminated.

With the increasing public and congressional concern for environmental preservation since the mid-1960's, attention has been focused on the suspected damaging aspects of dredging, particularly the disposal of dredged material into the aquatic environment. Legislation reflecting this concern requires the Corps and other Federal agencies concerned with the aquatic environment to give greater attention to the environmental impact of maintaining the waterway channels.

Controversy developed over whether the Corps was doing enough to counter known or suspected environmental effects from dredging and dredged-material disposal. The Environmental Protection Agency (EPA) and other agencies whose missions are related to environmental protection, have questioned the Corps' continued use of dredging and disposal practices which may involve unacceptable environmental risks. The extent of these risks, however, has not been fully identified or quantified. Alternative practices, while overcoming some of the environmental objections, can present additional problems such as greatly increased costs, difficulty in obtaining suitable disposal sites, and increased responsibilities for local sponsors of the projects.

#### SCOPE OF REVIEW

We examined files on operation and maintenance of selected dredging projects, as well as laws, regulations, procedures, and practices used by the Corps in its dredged-material research program and its dredging and disposal activities.

Our review was made at the following Corps locations:

- Office of the Chief of Engineers, Washington, D.C.,
- Waterways Experiment Station (WES), Vicksburg, Mississippi,
- Buffalo District, New York,
- New York District, New York,
- Mobile District, Alabama,

--San Francisco District, California, and

--St. Paul District, Minnesota.

We held discussions with officials of EPA, the United States Fish and Wildlife Service (USFWS) of the Department of the Interior, and the Corps. We also contacted local sponsors and officials of selected port authorities and the States of Alabama, California, Florida, Minnesota, and Wisconsin.

The remainder of this report describes several aspects of dredging and dredged-material disposal including environmental effects and risks, applicable legislation and litigation, criteria for disposal of dredged material, effects of alternative disposal methods, and research on dredging and dredged-material disposal. Our conclusions and recommendations are contained in a separate chapter because they generally relate to the entire topic of dredging rather than any specific chapter.

## CHAPTER 2

### ENVIRONMENTAL EFFECTS AND RISKS

When dredged material is disposed of in open water (see photograph on p. 6) or on wetlands it may (1) harm or kill bottom-dwelling organisms, (2) cause aesthetic problems (turbidity), and (3) destroy wetlands, which play an important role in the life cycles of wildlife.

In those cases where the material is contaminated, the effects can be more serious. The Corps is studying the extent of these effects and alternatives to these dredged-material disposal practices, but conclusive results have not yet been identified (see chapter 6).

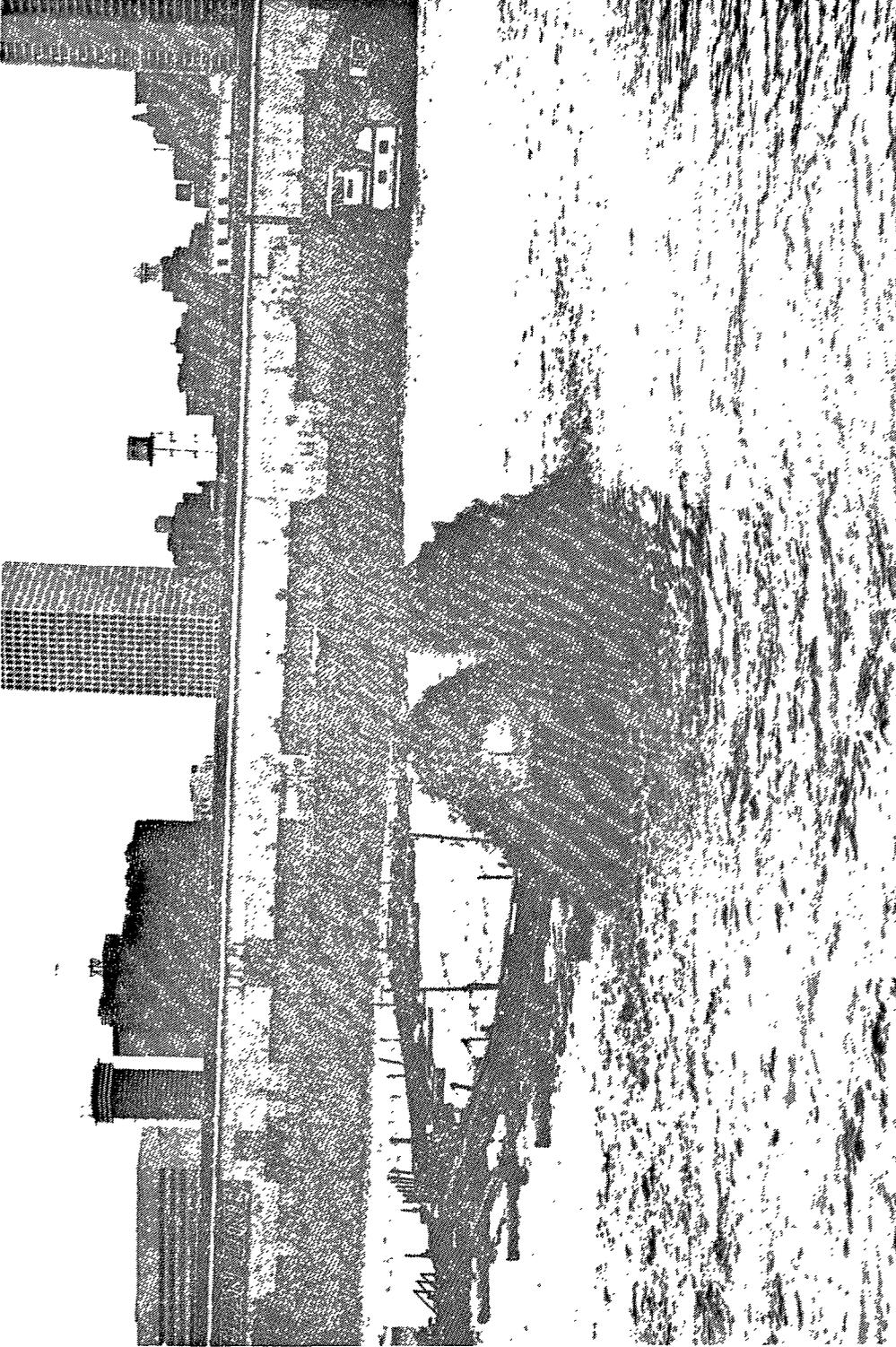
Dredging is required because material which enters streams and is deposited as sediment in navigation channels must be removed to maintain required depths. As a result of urban development and industrial and agricultural activity, the sediment has become increasingly contaminated, further increasing the potential for environmental damage from dredging and disposal activities.

The dredging process involves the removal of sediment from channels by hydraulic or mechanical means and can directly damage bottom-dwelling organisms in the channel. But the question which causes most of the environmental concern in the dredging process is how and where to dispose of the dredged material. The range of choices includes disposal in open water, wetlands, ocean waters, confined areas, or upland areas. Open water disposal has been most widely used by the Corps, and it has drawn considerable environmental objections, particularly when the dredged material is contaminated, or when it physically destroys or adversely alters aquatic systems.

Contaminants enter the water from various sources, including waste discharged by industry and municipalities and uncontrolled runoffs of agricultural fertilizers and wastes. Toxicants, such as heavy metals and pesticides, may enter the food chain and can affect the health of aquatic organisms and eventually affect humans who eat fish which were exposed to and accumulated the toxicants. Dredging and disposal of the dredged material resuspend or expose the contaminants in the water and may make them available to aquatic organisms. This exposure may or may not have a significant impact on aquatic organisms in any given case.

#### OPEN WATER DISPOSAL

When dredged material is dumped into open water, the bulk of it settles rapidly to the bottom, often trapping and



OPEN WATER DISPOSAL OF DREDGE MATERIAL USING PIPELINE DREDGE

SOURCE: GAO

smothering aquatic organisms and damaging or destroying their habitat and the plants on which they depend for food. The Corps' researchers said that such impact has been found through field studies to be of short duration and generally of little regional ecosystem consequence because of the resiliency of many aquatic organisms.

Finer particles which do not settle remain suspended and concentrated for some time in the water at the disposal area until dispersed by the flow of water or aggregated into larger particles. This condition, called turbidity (see photograph on p. 8), may screen out sunlight needed by aquatic plants and create aesthetic problems. Open water disposal can also cause the formation of mounds of dredged material which can alter water circulation.

The concerns become more severe when the dredged material is contaminated. Aquatic organisms in the area may die or store the contaminants in their tissues and pass them through the biological food chain. Human health could be affected by having body contact with water containing toxic levels of contaminants, or by consuming fish or wildlife which have been exposed to the contaminants. WES officials said that recent research results indicate that uptake (body absorption through food consumption) of toxicants by aquatic organisms has been minimal in marine and estuarine sediments.

#### WETLANDS DISPOSAL

The use of wetlands as dredged-material disposal sites has been practiced by the Corps for many years. Because of proximity to the dredging operations, it is usually one of the least expensive disposal methods. In recent years there has been increased awareness of the functions coastal and inland wetlands serve, including food chain production, general habitat and nesting areas for wildlife, spawning and rearing areas for aquatic and land species, and flood and erosion protection.

In a 1969 report, the Commission on Marine Science, Engineering, and Resources concluded that coastal estuarine waters and marshlands were vital to the life support of much of our marine fisheries' harvest. Seven of the ten most valuable species for the Nation's commercial fisheries spend all or important portions of their life cycles in estuarine waters. The report pointed out that in the preceding 20-year period, 569,000 acres--7 percent of about 8 million acres considered to be important habitat--were lost through dredging and filling.

In its September 1975 guidelines on the discharge of dredged material, EPA described disposal operations in wetlands



DISPOSAL FROM HOPPER DREDGE, TURBIDITY CAUSED BY  
DREDGING OPERATION

SOURCE CORPS OF ENGINEERS

as being most severe, and stated that destruction of highly productive wetlands may represent an irreversible loss of a valuable aquatic resource.

In November 1976 the Corps estimated that 7,000 acres of land are needed annually for new dredged-material disposal facilities. This figure represents total land requirements, including both upland areas and wetlands. Individual acreage records for each, however, are not maintained by the Corps. The Corps told us that wetlands are still used because these are sometimes the closest and cheapest disposal alternative, and because in some cases there are no economically viable alternatives available.

EPA officials told us that a major concern of conservation and environmental interests is the long-term cumulative effects of dredging activities. This concern is recognized by the Corps, and is reflected in one of its dredging regulations which states that, although individual alteration of wetlands may constitute a minor change, the cumulative effects of numerous piecemeal changes often result in a major impairment of the wetland resources.

EPA officials said that an illustration of such long-term effects is contained in the Corps' April 1976 Environmental Impact Statement for the Lower Mississippi River and Tributaries. The impact statement points out that riverine habitat loss over the last 100 years has been significant, and acknowledges that continued maintenance dredging will further reduce wetland habitat.

EPA officials believe that such long-term effects should be fully considered in making decisions involving economic and environmental values in selecting disposal sites for dredged material.

## CHAPTER 3

### IMPACT OF ENVIRONMENTAL LEGISLATION

#### AND LITIGATION ON CHANNEL AND HARBOR MAINTENANCE

During the past decade, new legislation and related legal actions have affected the Corps' mission to maintain the Nation's waterway system. As a result, the Corps has been required to assess the environmental impact of its dredging and disposal activities; consider the views of other Federal, State, and local agencies in making its decisions; and comply with EPA dredged-material disposal guidelines. In addition, the Corps has been required to use confined disposal facilities for dredged material classified by EPA as contaminated on the Great Lakes, and to conduct a research program on the effects of, and alternatives to, its dredged-material disposal practices.

#### ENVIRONMENTAL LEGISLATION

Section 102 of the National Environmental Policy Act of 1969 (Public Law 91-190, January 1, 1970) requires all agencies of the Federal Government to prepare detailed environmental impact statements on major Federal actions significantly affecting the quality of the human environment. These statements include such factors as

- the environmental impact of the proposed action,
- any adverse environmental effects which cannot be avoided should the proposal be implemented, and
- alternatives to the proposed action.

Whether the Corps would prepare environmental impact statements for maintenance dredging projects was initially questioned since these were continuing activities. Corps officials told us that emphasis was given to environmental assessment and Environmental Impact Statement preparation for new construction activities since the Corps felt that maintenance dredging projects caused less environmental impact. The Corps decided to prepare statements for maintenance dredging projects based on (1) a Council on Environmental Quality interpretation of its guidelines and (2) a 1974 court decision. This process permits appropriate Federal, State, and local governments, as well as interested individuals and groups, to comment on the Corps' dredging activities.

The Corps has established an internal policy, effective January 1, 1976, not to perform maintenance dredging on any project for which an environmental impact statement or assessment has not been prepared.

Section 123 of the River and Harbor Act of 1970 (Public Law 91-611, December 31, 1970) authorized the Corps to build, operate, and maintain confined disposal facilities for contaminated dredged material on the Great Lakes and their connecting channels. Under the Great Lakes Confined Disposal Program, which was authorized by this law, the Corps places dredged material determined to be contaminated by EPA behind retaining dikes, thereby reducing the threat of potential environmental damage. The Corps plans to construct 46<sup>a</sup>/ such facilities at a cost of about \$263 million. The Corps told us that confined disposal facilities' use on the Great Lakes costs 3-1/2 times more than open lake disposal methods. This program is discussed in greater detail in appendix I.

Section 123 also authorized the Corps to conduct a comprehensive research program on the effects of, and alternatives to, dredged-material disposal practices. The program, which is a \$30 million effort planned for completion in 1978, is discussed in greater detail in chapter 6.

Section 404 of the Federal Water Pollution Control Act Amendments of 1972 (Public Law 92-500, October 18, 1972) and section 103 of the Marine Protection, Research, and Sanctuaries Act of 1972 (Public Law 92-532, October 23, 1972) (Ocean Dumping Act) required that EPA, in conjunction with the Secretary of the Army, establish and apply guidelines and criteria for the discharge of dredged material into inland and ocean waters. The Ocean dumping criteria were published in the Federal Register in October 1973 and were revised in January 1977. The inland guidelines were published in September 1975.

These two acts have not had a significant overall impact on the performance or costs of channel maintenance. Potentially, the impact from these acts could be substantial because they give EPA, rather than the Corps, the final authority as to where dredged material can be dumped. EPA officials told us that to minimize these potential impacts, EPA and the Corps have established a joint committee to work on the continued refinement of these criteria and guidelines.

#### LITIGATION ON STATE REGULATIONS

The State of Minnesota brought suit against the Corps in the United States District Court, District of Minnesota, in March 1975. The State claimed that the Corps had violated State laws and regulations which

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<sup>a</sup>/Includes five land facilities requiring very limited construction.

- require secondary treatment of dredged spoil,
- forbid discharges into navigable waters in violation of State water quality standards, and
- require all dredgers to obtain a State disposal permit.

The issue was mainly one of decisionmaking responsibility--whether the State or the Corps was responsible under the Federal Water Pollution Control Act Amendments of 1972 for regulating dredged or fill material discharge into navigable waters. Section 402 of the act authorizes States to establish permit programs to regulate discharges of all pollutants into the navigable waters. If the State's program is approved by EPA as meeting applicable Federal standards, State permits issued to those proposing discharges into the waters replace Federal permits, which otherwise are required. Section 404 of the act, however, gives the Corps permit-granting authority over the discharge of dredged or fill material at specified disposal sites. The Corps contended that this latter authority (section 404) was controlling over its own dredging activities as opposed to State control. The District Court held otherwise, however, in an October 9, 1975, decision, that section 404 is applicable only if there was no approved State permit program under section 402 of the act, or if the approved State program did not try to regulate dredging, neither of which was the case in Minnesota.

The Corps also contended that to compel it to obey State requirements would impair its authority to maintain navigation and would violate an express provision under section 511 of the act which protected that authority. The Court's ruling on this question was also against the Corps, stating that the Corps' compliance with State permit requirements would not affect the Corps' authority to maintain navigation, but would merely require maintenance in compliance with effluent limitations established pursuant to the act. The Corps appealed this decision in January 1976, and an October 1976 decision on the appeal by the U.S. Circuit Court of Appeals for the 8th Circuit reversed the District Court decision, stating that the Congress had not intended to waive the immunity of the Federal Government from State regulations. As a result, the Corps does not have to comply with individual State standards relating to discharges into navigable waters in its dredging activities. Both EPA and the Corps told us EPA guidelines and criteria are now the only mechanisms governing Corps' dredging and disposal operations in State waters.

On January 26, 1977, the State of Minnesota appealed the decision to the Supreme Court which, on April 25, 1977, decided not to hear the case.

## CHAPTER 4

### PROBLEMS IN DEVELOPING CRITERIA FOR DISPOSAL OF DREDGED MATERIAL INTO NAVIGABLE AND OCEAN WATERS

Because contaminated dredged-material disposal may potentially have adverse environmental effects, there is a need to identify the levels at which concentrations of various contaminants become unacceptable for disposal in the aquatic environment. However, cause and effect relationships between materials considered to be contaminated and significant environmental damage are often difficult to verify with current analytical procedures. Furthermore, Corps' researchers believe it may not be possible to establish such relationships.

Knowledge of these effects is critical to future dredged-material disposal practices. The Corps uses water disposal sites for about 65 percent of the material it dredges, and based on criteria existing in 1973, the Corps estimated that a high percentage of the material contained chemicals in potentially toxic concentrations.

Guidelines to determine the polluted nature of dredged material were first developed by EPA in January 1971. Since then EPA, in conjunction with the Corps, has published three additional sets of regulations--one for inland waters and two for ocean waters. But until more scientific evidence is developed on cause and effect relationships, decisions regarding the acceptability of dredged material for disposal in open water will often be subjective, and will be based on case-by-case analyses.

#### DEVELOPMENT OF PREDICTIVE CRITERIA

A Corps' study stated that the criteria for determining the acceptability of disposing of dredged material into the water should address the question: does the dredging and disposal of sediment known to contain various contaminants cause them to be released to the water column (dissolved), or in any other way to become more available to the biological food chain? Currently, there is no single test which answers that question. Neither the Jensen criteria nor the elutriate test fully predicts the long-term behavior of contaminated dredged material after it enters the water. Bioassay test procedures (discussed below), adopted in January 1977 as part of the revised ocean disposal criteria, however, were developed to predict the effects of proposed disposal operations on aquatic organisms on a short-term basis.

## Jensen criteria

The Jensen criteria consider sediment from an area to be polluted and unsuited for open-water disposal, in all cases, if any one of seven pollution parameters are exceeded, based on test results of sediment analyses. The parameters purport to predict the effect disposal would have on the short-term oxygen supply in the water and on the water's contamination through exposure to oil, grease, mercury, lead, and zinc. The test itself, however, is not conclusive, since those making the tests are permitted to use discretion in deciding whether the material is too polluted for water disposal after considering other factors such as the sources of contamination, the condition of the proposed disposal area, certain biological and chemical indicators, and field observations. Corps' researchers said that the mere presence of a contaminant in a sediment is not an indication of its potential to create environmental damage.

The Jensen criteria were adopted by the newly created EPA in January 1971 for use by its regional offices in deciding whether to oppose Corps' practices of dumping material dredged from a given area into the water. Subsequently, EPA rescinded its requirement that the Corps use the Jensen criteria, and instead endorsed the use of the elutriate test for inland disposal, and required its use for ocean disposal.

## Elutriate test

The elutriate test was designed to predict the increase in the concentration of contaminants in the water at the proposed disposal site. It involves a laboratory simulation of the disposal process and compares the concentration of contaminants in the water at the disposal site before and after disposal. In the ocean disposal criteria, if the test showed that the concentration of any one of the designated contaminants would not be increased by more than 1.5 times, the sediment was considered suitable for open water disposal. The 1.5 factor is not used in the elutriate test procedures when applied to inland disposal situations.

The elutriate test overcame one of the principal objections to the Jensen criteria, that they did not fully reflect the knowledge that some contaminants did not remain suspended in the water and affect water quality and aquatic organisms, but settled with the main particles of sediment.

The elutriate test, on the other hand, did not resolve two areas vital to the development of valid criteria for predicting effects of the contaminated sediment on water quality and aquatic organisms.

--Evidence gathered thus far has not proven whether an increase of pollutants in the water at the disposal site by a factor of 1.5, which was subjectively derived, is too lenient or too strict.

--The test does not measure the potential effects which contaminants settling at the disposal site may subsequently have on bottom-dwelling fish and shellfish, nor does it consider the possibility that, through chemical actions, the contaminants may in time be released into the water.

### Inland disposal guidelines

The EPA publication of guidelines for selecting disposal sites in inland waters, as required by the Federal Water Pollution Control Act Amendments of 1972, was delayed until September 1975, about 3 years after the act was passed, because of lengthy negotiations over the guidelines between the Corps and EPA. The published guidelines do not prescribe any single test which would dictate disposal site selection. The Corps, in consultation with EPA, chooses one or more tests from several contained in a comprehensive testing, evaluation, and review procedure to evaluate any given case. Disposal decisions, however, are subject to EPA's review and it may deny the Corps use of a site if it finds that the planned disposal would have an unacceptable adverse effect on municipal water supplies, shellfish beds and fishery areas, wildlife, or recreational areas. Because the guidelines were not specific in terms of what material would be considered unsuitable for aquatic disposal, the impact on the Corps' disposal practices cannot be assessed.

### Ocean disposal criteria

Ocean disposal criteria issued by EPA in October 1973 pursuant to the Ocean Dumping Act required the Corps to apply the elutriate test in selecting sites at which contaminated dredged material may be dumped. In perhaps the most important conflict between the Corps and EPA over the validity of the test as criteria, EPA challenged the Corps' use of the disposal site off the coast of New Jersey--the New York Bight--where most of the material dredged from the New York Harbor area is dumped. This conflict is discussed in more detail in Appendix II.

In a complaint filed in the U.S. District Court for the District of Columbia in November 1975, the National Wildlife Federation challenged the legal sufficiency of EPA's ocean dumping criteria. To overcome the shortcomings of the previous testing procedures and the objections of the National

Wildlife Federation, EPA revised its ocean dumping criteria in January 1977. These new criteria (1) eliminated the arbitrary 1.5 factor discussed on pages 14 and 15 and (2) now consider the effects of ocean disposal on bottom-dwelling (benthic) aquatic organisms.

Under the revised ocean disposal criteria, the first step is to determine the source and nature of the dredged material. The dredged material may be considered acceptable for ocean disposal without further testing if (1) the dredged material is made up of sand, rock, and/or gravel and there is no known source of pollution in the material's area of origin or (2) the disposal operation will not exceed applicable water quality criteria for ocean waters.

When the dredged material does not meet the above conditions, further testing of liquid, suspended particulate, and solid phases of the dredged material is required. During this testing, aquatic organisms (either those native to the proposed disposal area or other appropriate sensitive marine organisms) are subjected under test conditions to the three phases mentioned above. This procedure is known as the bioassay test.

If these bioassay tests show no unreasonable toxic or other adverse effects on the tested organisms within a 96-hour test period, the dredged material is considered acceptable for ocean disposal.

Although the above procedure is applicable to almost all dredged material disposal operations in ocean waters, each operation is still evaluated on a case-by-case basis. An EPA official told us that in some instances where special circumstances are present (for example, the potential for contaminants being released from the settled dredged material over an extended time period), additional testing may be necessary.

To refine the existing criteria, EPA and the Corps established in October 1975 a joint committee to coordinate research and work on the technical aspects of regulatory criteria for the discharge of dredged and fill material. Based on the information developed by this committee, the Corps and EPA plan to prepare implementation manuals in 1978 to supplement both the inland and ocean dumping regulations for dredged material.

## CHAPTER 5

### EFFECTS OF ALTERNATIVE

#### DISPOSAL METHODS

There are several alternatives to the Corps' traditional practice of disposing of dredged material in open water or on wetlands, including

- deep ocean waters' use,
- land disposal, and
- selective placement in open water.

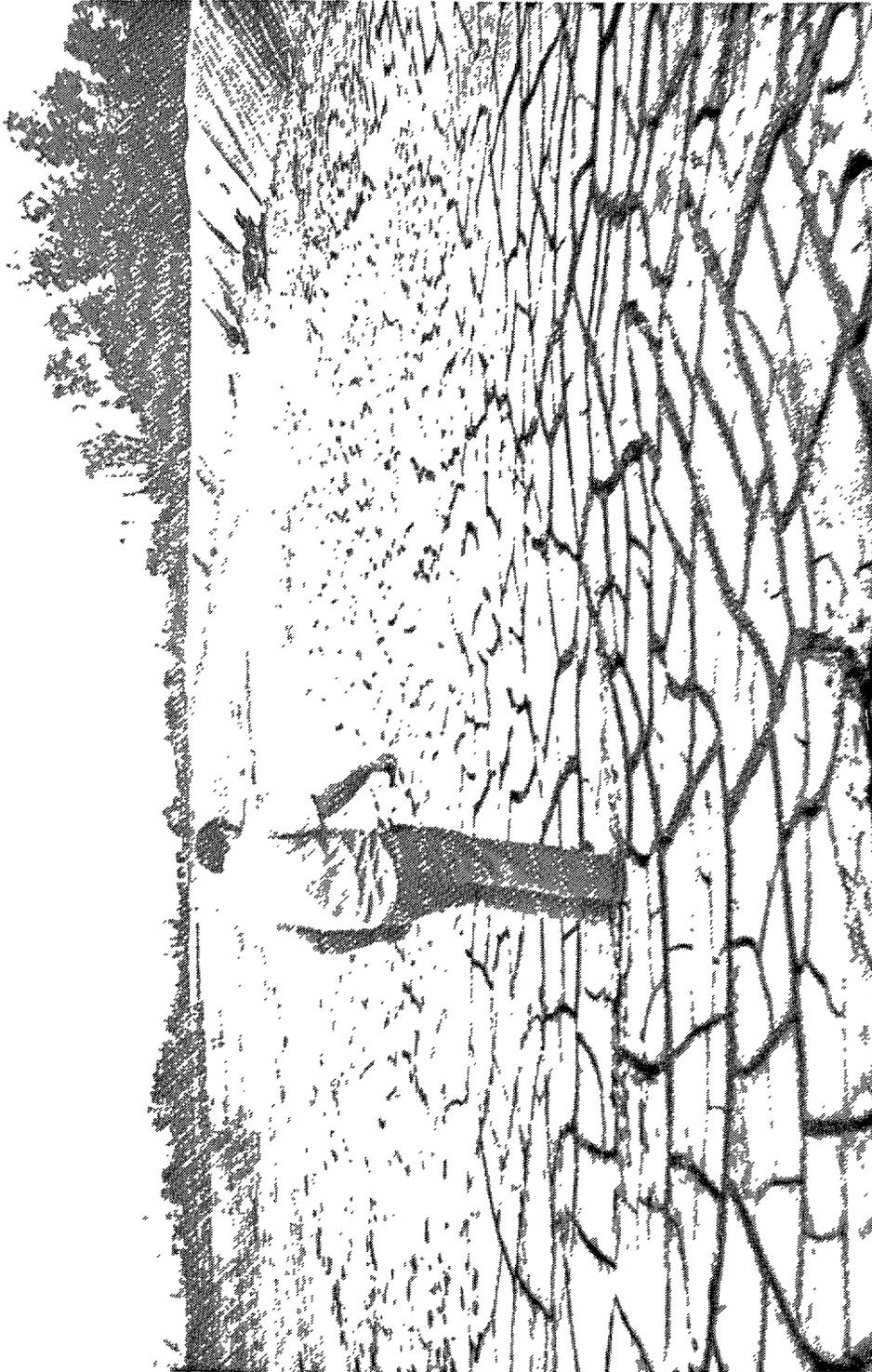
These alternatives are considered by some to be more environmentally acceptable than traditional methods, but can increase Federal costs, as well as local sponsors' responsibilities, and may affect the economic viability of some waterway projects.

#### ALTERNATIVE DISPOSAL METHODS

Long-term environmental effects of deep ocean disposal have not yet been thoroughly studied and so are not well known. Some scientists, however, consider deep ocean areas to be an acceptable place to dispose of many types of waste, including dredged material, because of the low biological productivity in these areas.

Land disposal is considered by some to be more environmentally acceptable than open-water or wetland disposal, particularly when the material is contaminated, because it removes the material from the aquatic environment. Corps' officials told us that under certain situations land disposal may pose a greater risk of long-term adverse ecological impact than open water disposal because of geochemical changes in the sediment and the possibility of leaching (leaking of soluble substances from solid material). Land disposal areas can either be diked areas (see photograph on page 18) along the shoreline (confined disposal) or upland areas away from the shore and wetlands. Confined disposal has been used frequently by the Corps, but because of higher transportation costs, upland areas have not.

In selective placement, dredged material is disposed in the aquatic environment, but the number of disposal locations is reduced. For example, selective placement of dredged material would limit disposal to a selected number of locations in the open water, instead of in the entire length of the waterway.



CONFINED (DIKED) DISPOSAL AREA CONTAINING DRIED DREDGE MATERIAL

SOURCE CORPS OF ENGINEERS

POTENTIAL EFFECTS OF  
ALTERNATIVE METHODS

Increased costs

The use of alternative disposal methods will generally cost more than present methods because these methods will require

- more transportation (deep ocean, land disposal, and selective placement),
- the construction of containment facilities (land disposal),
- the purchase of land (land disposal), and
- additional equipment (deep ocean, land disposal, and selective placement).

In the past, availability and economy were the Corps' principal criteria for selecting a disposal site. Since the passage of environmental legislation in the last 5 years, other factors, such as potentially adverse effects on water supplies and on fish and shellfish consumed by man, have been given added weight in the selection of dredged-material disposal sites.

Estimated cost increases for alternative methods for projects we reviewed are shown in the following table.

<u>Location</u>	<u>Estimated cost increases (percent)</u>	<u>Method</u>
Great Lakes	356	confined
New York Harbor	220	deep ocean
San Francisco Bay	a/988 to 1088	land, deep ocean
Upper Mississippi River	b/390	selective placement
Gulfport Harbor	1224 to 1519	upland, ocean
Mobile Harbor	c/65 to 147	confined

a/Mare Island Strait Project.

b/Head of navigation to Guttenberg, Iowa.

c/River channel portion of project.

Details on the cost increases for each of the locations are discussed in appendices I through V.

The Corps has not prepared information on the nationwide costs of using alternative disposal methods.

EPA officials said that they believed that although alternative disposal methods often result in increased costs, these costs are often offset by environmental and economic benefits resulting from the use of the alternative methods. For example, they said that traditional disposal practices sometimes include dumping material near the dredging site where material often returns to the channel or harbor, necessitating the extra expense and associated potential environmental damage of redredging. They also told us that they believed dredged material can be used productively, such as for beach nourishment or wetland creation.

EPA told us that they believe that an investment in more modern dredging technology can reduce costs and, at the same time, better protect the environment. They said that most dredging equipment now used in the United States is not designed for cost-effective dredged-material removal and transportation (see app. VII).

Corps officials told us that both the private industry and the Corps dredging fleets consist of rather old equipment, and that they generally agreed with the basic points expressed by EPA. Corps' officials pointed out, however, that over the last 8 to 10 years, funding for new equipment development and modernization of existing equipment has been very limited. Corps officials told us that uncertainty about whether the Corps or private industry will play the lead role in future dredging operations has been a key to the lack of new dredging equipment development. They told us, however, that the latest available technology will be considered in the development of future dredging equipment in the Corps' fleet.

#### Increased responsibilities of local sponsors

The responsibility for acquiring land for disposal sites is assigned to either the Corps or the local sponsor in the legislation authorizing particular projects. With an increasing trend toward land disposal and the generally higher costs of acquiring land, responsibilities of local sponsors will increase. Because of increased costs, many local sponsors may be reluctant to fulfill their sponsorship agreements, making it difficult for the Corps to carry out its mission to provide for navigation.

The Corps' policy is to continue open water disposal on projects where it is now used unless local interests provide suitable alternate confined areas at no cost to the Government. When the Corps does not have the authority and the local sponsor does not have the means to provide land facilities, the alternatives are to suspend dredging, or to continue to use the existing disposal method.

Some of the difficulties experienced by the Corps with local sponsorship agreements are illustrated in the following examples.

In 1971 four Florida counties notified the Corps of their inability to provide land disposal sites for the placement of material dredged from the Apalachicola River as required by agreements they had signed with the Corps. The Corps estimated that it would require \$600,000 to acquire upland sites for disposal of the material. Several Federal and State agencies objected to the Corps' initial plan to obtain disposal easements without charge from property owners whose land adjoined the 104-mile length of the river because of possible environmental degradation.

The Redwood City Harbor in California was not dredged in 1974 as scheduled, or in 1975 as rescheduled, because the local project sponsor, the Port of Redwood City, had not found an acceptable land disposal site. When the harbor was dredged in 1970, the dredged material was dumped at a nearby aquatic site. However, environmental regulations precluded further dumping at this site, and the nearest acceptable aquatic site was located 24 miles from the harbor. Because use of that site would increase the cost of dredging the harbor over 2-1/2 times the cost of using land disposal, the Corps required that the sponsor provide a land disposal site.

#### Prospective abandonment of channels

Federal policy for the construction of new channels requires showing that the project will return benefits greater than the cost of construction and later maintenance. After a project is constructed, however, the Corps does not routinely weigh the benefits and costs of maintaining waterways and harbors. Factors which enter into decisions for continued maintenance include

- prospective future increases in benefits (increased traffic),
- the effect on the local economy and on business firms induced to locate on the waterway by the presence of the channel, and

--national defense needs.

Increases in dredging costs due to environmental concerns could adversely affect the economic viability of some projects.

The Corps' Mobile District analyzed the effect of proposed alternative disposal practices on the benefit-cost ratio for the Gulfport, Mississippi, harbor project.

USFWS had suggested that the Corps abandon the use of dredged-material disposal sites along the Gulfport harbor and ship channels for more environmentally acceptable sites. USFWS predicated its suggestion on the belief that disposal of dredged material in open water areas is often environmentally undesirable. USFWS specifically noted that marine grass beds (used for fish and wildlife habitat) could be damaged as a result of using the existing sites. The Corps' Mobile District estimated that the cost of dredging the channels would be increased from \$680 thousand to \$9.0 million annually for land disposal or to \$11.0 million annually if the material is taken to deep ocean waters for disposal. Either alternative would cause the channels' maintenance costs to greatly exceed the calculated economic benefits which the harbor returns (about \$2 million annually), reducing the benefit-cost ratio from 2.98 to 1, to 0.2 to 1.

Since the Corps does not routinely compute benefits and costs for existing projects, the impact of higher dredging costs on the economic viability of any given project is generally not fully assessed. It is reasonable to assume, however, that smaller waterways with limited traffic which require alternative disposal methods would be the most severely affected.

## CHAPTER 6

### RESEARCH ON DREDGED MATERIAL DISPOSAL

For several years, the Corps has been studying the effects of, and alternatives to, traditional dredged-material disposal practices. Progress has been made in identifying the effects of dredging, the alternatives to traditional practices, and the effects of implementing the alternatives. Research to date, however, has not fully identified or quantified the long-term environmental risks of dredged-material disposal operations.

Most of the research on the environmental effects of dredged-material disposal has been performed since 1966, when the Corps began studying the effects on water quality and water organisms of open-water disposal of contaminated dredged material from Great Lakes harbors. The results of this study--which was completed in 1969--were inconclusive. These results, and increasing concern over the effects of dredging operations in other parts of the Nation, led to the development of the Dredged Material Research Program (DMRP).

USFWS has played an active role in the DMRP, but EPA had not directly participated in the DMRP until an EPA/Corps Committee was established in October 1975. (See p. 28.)

The DMRP, to be completed in 1978, should add to the body of knowledge on the effects of, and alternatives to, traditional dredging practices, but it is questionable whether the program will answer all questions on the effects of, and alternatives to, traditional practices. According to DMRP officials, additional work will need to be done under the general categories of (1) conducting follow-on research, (2) promoting technology transfer, and (3) conducting new research. DMRP officials told us that this additional work could be started before the DMRP is completed if additional personnel and funding were available.

#### OBJECTIVES AND STATUS OF THE DMRP

The DMRP was authorized by section 123 of the River and Harbor Act of 1970 which called for the Corps to conduct a comprehensive research program on the characteristics of dredged material and alternative methods for its disposal. The Corps assigned this task to WES.

In 1971 WES started a study to identify and assess the problems, and to develop a proposed research plan. This work was completed in November 1972, and in 1973 the Office of Dredged Material Research was established to conduct a 5-year, \$30-million study designed to identify:

- The effect on water quality and aquatic organisms of dredged-material disposal in water.
- Potential uses of dredged material for creating wild-life habitat.
- Better ways of managing material placed in confined land facilities.
- The potential for productive uses of dredged material.

As of January 1, 1977, 148 research units had been completed, 88 were in active status, and 24 more were planned.

WES' guidelines for the study provided that:

- The research would avoid problems restricted to one area or a single dredging project.
- A majority of the research (a goal of 70 percent was established) would be done under contracts with private industry, universities and institutes, other Federal agencies, Corps district offices, and other Corps laboratories.
- Independent technical consultants and a technical advisory board would direct and guide the program.

According to WES officials, the research is expected to be completed on schedule in March 1978, but additional research and/or follow-on evaluation studies will be desirable after that date.

#### Effects of open water disposal on water quality and aquatic organisms

When the DMRP was initiated in 1973, research centered on the effects of open water disposal on the water column (the water area between the surface and bottom of the disposal area). As a result, much of DMRP's research was focused on measuring the effect on water quality and aquatic organisms of the release of chemicals contained in dredged material. Previous research had established that some of the chemicals disturbed in the dredging and disposal process were dissolved in the water and thereby became more readily available for entry into the food chain. The remaining portion remained attached to other sediment particles (soils and other non-chemical solids) and settled in an undissolved state.

Corps officials told us that DMRP laboratory studies revealed that chemical effects on the water column at a

disposal site were insignificant to nonexistent. A contract study performed for the DMRP concluded that only ammonium, iron, and manganese were shown to be released in significant quantities, but none of these constituents were considered to be highly toxic and all are required nutrients for organisms.

The Corps said that DMRP field studies at two sites produced preliminary results indicating that

- water quality effects of open water disposal of both contaminated and uncontaminated dredged material were minimal,
- ammonia and manganese were the only constituents released to the water column in significant concentration, and
- heavy metals and nutrients were found to either show no significant release, or to decrease in concentration during disposal.

Corps officials said that other results of field investigations have shown that bottom-dwelling organisms have migrated upward through coverings of various depths of dredged material. Another study showed little uptake of heavy metals from heavily contaminated sediments. According to the Corps, the long-term effects of dredged material on aquatic organisms after the material has settled have not been fully or satisfactorily established.

Because WES' concerns about the effects of contamination in the water column have decreased, emphasis has been shifted to examining the longer-term effects of dredged-material disposal on bottom-dwelling communities.

#### Use of dredged material for creating wildlife habitat

The overall objectives of the habitat development project were to evaluate the feasibility of establishing productive biological habitats on dredged material, and to identify the environmental impacts associated with the disposal of dredged material on wetlands. The project consists of five inter-related tasks: (1) the effects of marsh and terrestrial disposal, (2) marsh development, (3) terrestrial habitat development, (4) aquatic habitat development, and (5) island habitat development. As of April 1977, some preliminary results had been obtained, but a final report on this segment of the research had not been published.

### Other productive uses

WES has completed a marketing survey which showed that there is potential for using dredged material to serve landfill and construction needs. The survey showed that potential future uses of dredged material as sanitary landfill cover, fill for strip-mined areas and abandoned quarries, park development, industrial parks, beach nourishment, and airfield and highway construction, would substantially exceed the available volume of dredged material. The location and timing of the uses, however, often do not coincide with the availability of the dredged material.

WES concluded that it would be practical to stockpile the material at locations strategic to needs and that it could be sold to recover transportation costs after it had been cleaned and dewatered. A WES contractor also recommended use of the material for creating new land either by extending shorelines or creating artificial islands. The land could be sold to recover the costs of its creation.

The actual economic feasibility of these approaches, however, had not been demonstrated.

### Results obtained from completed research

As of January 1, 1977, 87 reports had been published or were being reviewed for publication. DMRP officials said that although they are incomplete, research results were confirming that:

- Water column impact during disposal appeared to be minimal to nonexistent, and the effect was predominately aesthetic in nature.
- Leaching of toxic heavy metals from disposal mounds into the water column appeared no greater than from natural sediments.
- The major bottom impact found at disposal sites was the physical mounding of the material; benthic recolonization of the mounds appears relatively rapid.
- Toxic heavy metal uptake studies suggest minimal to no impact in marine and estuarine sediments.
- Petroleum and chlorinated hydrocarbon uptake studies suggest minimal uptake from the solid phase of sediments.

- Creation of marshlands and artificial habitat might be viable cost-effective alternatives for dredged-material disposal.
- Equipment was available which better controlled the adverse effects of the physical act of dredging.
- Productive uses could be made of dredged material, e.g., strip mine reclamation, development of additional recreational, and industrial land-use sites.

#### Limitations of the DMRP

The DMRP has not concentrated much attention on river disposal areas (such as the Upper Mississippi River) and ocean waters outside the 3-mile limit, even though these areas are used as dredged-material disposal sites. The director of the DMRP told us that much of the research done in coastal areas is applicable to river dredging. He acknowledged that research in deeper ocean waters is needed, but told us that because of the high costs of such research in comparison with the amount of material disposed of in these areas, it was not included in the research program.

#### Post-DMRP study

After the DMRP is completed in 1978, several environmental questions regarding dredging and disposal operations will remain, and additional work will be needed.

A post-DMRP study is proposed by WES to begin in 1978 when the DMRP is completed. According to WES, preliminary cost estimates range from \$9 million to \$15 million and the post-DMRP could be completed in 3-1/2 to 5 years depending on which of several options is chosen. A DMRP official told us that, given additional manpower and funds now, the project could start within 9 months, thereby shortening the time period for completion of the follow-on work by about 6 months. The additional research needs identified for the post-DMRP study include:

- Continued monitoring of selected field sites to assess long-term effects of marsh and terrestrial development.
- Continued monitoring of open water disposal to evaluate ecological impact and develop procedural guidelines for routine operations.
- Study of ecological problems associated with confined disposal areas and comparison of the effects of disposal alternatives and dredging techniques.

- Evaluation of concepts and assessment methodologies for disposal area re-use, disposal area sizing, and material dewatering.
- Establishment of a WES advisory group to provide assistance to Corps' districts in application of DMRP technology.
- Identification of new issues and needs relating to a combination of dredged material with solid and liquid wastes.
- Developing and refining techniques for evaluating existing aquatic ecosystems, and predicting the impact dredged-material disposal has on them.

#### Federal agencies' involvement in the DMRP

To encourage their involvement in the research program, WES invited other interested Federal agencies to contribute researchers to work on the program. Arrangements were made for a scientist from the USFWS to be assigned full time to assist with research planning, development, and management as a member of the technical advisory board. The USFWS representative told us that he has coordinated USFWS objectives with DMRP objectives and he believes his input has been a benefit to the research program.

Section 123 of the River and Harbor Act of 1970 called for the facilities and personnel of EPA to be utilized for that part of the research which involved water quality. Through December 31, 1976, EPA was conducting three research segments at its labs for the DMRP, but EPA has not been directly involved in the overall management of the DMRP, or in the evaluation of research results.

The director of the DMRP and the USFWS representative to the DMRP told us that they believed a full-time EPA representative on the DMRP would be valuable to both EPA and the research program.

An EPA official told us that he believed a joint EPA/Corps committee on the technical aspects of regulatory criteria for the discharge of dredged and fill material was an adequate mechanism for EPA coordination with the DMRP. This committee, which meets at least three times a year, was established in October 1975 to insure technically sound and implementable criteria for disposal of dredged material in inland and ocean waters by (1) research coordination and planning, (2) providing interim guidance for

existing evaluation procedures, (3) preparing an in-depth implementation manual, and (4) recommending technical revisions based on research results.

It seems to us that EPA should have played an active part in the DMRP as it was being conducted. We recognize that since the research program is nearing completion, the value of EPA's direct participation in the program is reduced. Nonetheless, we believe that it would be valuable for EPA to participate in the final stages of the DMRP when final conclusions of the 5-year research effort will be developed. If a follow-on program to the DMRP is to be conducted, we believe that EPA should participate fully in the initiation and conduct of the program by assigning staff to work directly on the program.

We believe that EPA's participation in the final stages of the DMRP, and more importantly, in any follow-on program is particularly important because EPA is responsible for establishing criteria and guidelines for dredged-material disposal operations to which the DMRP and follow-on program research results will apply.

#### OTHER RESEARCH STUDIES

Research in individual Corps' districts has for the most part been independent of the DMRP. In the districts included in our review, the research has tended to be inconclusive. It especially has not dispelled concerns about long-term effects of dredged-material disposal on the aquatic environment.

Research studies have been, or are being, conducted in the San Francisco Bay area, Mobile Harbor, New York Harbor, and the Upper Mississippi River. These studies were concerned with the effects on the local environment of dredging and disposal activities.

Other Federal agencies--such as EPA, NOAA, and USFWS--perform research related to the marine environment. For example, NOAA is conducting a study of water pollution in the New York Metropolitan area which includes a study of dredged-material disposal in the New York Bight.

EPA is conducting research on

--bioassay procedures to estimate the ecological impact on the marine and estuarine environment of dredged-material disposal,

--procedures and guidelines for assessing the biological effects of ocean disposal, and

--the magnitude and distribution of settled and suspended material resulting from dredged-material disposal and the effects of pollutants on freshwater ecosystems.

Corps' officials told us that the EPA research is being coordinated with the DMRP.

## CHAPTER 7

### CONCLUSIONS AND RECOMMENDATIONS

Waterborne commerce plays an important part in the national transportation system. To create and maintain the harbors and channels for this commerce, dredging is required which entails the removal of large quantities of sediment. The discharge of municipal, industrial, and agricultural wastes into the Nation's streams has caused this sediment to become increasingly polluted, particularly near large metropolitan areas.

In less than a decade, the creation and maintenance of our navigable waterways has changed from an activity that occurred relatively unnoticed to one that has created substantial controversy. On the grounds that the activity may seriously damage the environment, threaten human health, or reduce benefits of alternative uses of water resources; the policies, criteria, and assumptions inherent in earlier dredging practices have been challenged and in some cases changed. Corps' officials believe, however, that in many cases insufficient evidence of these hazards exists to warrant the economic consequences of adopting alternative measures that have been proposed.

To confirm or dispel the need for substantial changes in dredging and disposal methods, the Corps is conducting a research program on the effects of, and alternatives to, its traditional dredging and disposal practices. Although incomplete, preliminary results of the research indicate that the effects of open water disposal on the water column (the area above the disposed material) are less severe than had been originally thought. The long-term effects, however, are still relatively unknown. It is questionable whether the present research program will conclusively answer all the questions about the environmental effects of, and alternatives to, traditional dredging and disposal practices.

The current research program is planned for completion in early 1978, but program officials have told us that a follow-on program is desirable to continue monitoring on-going research to determine long-term effects, do new work, and facilitate the transfer of information learned in the program to a form usable by Corps' districts. They told us this follow-on program could be started now if additional personnel and funding were available. Information on the extent to which the follow-on program could be expedited with more funding and personnel could be of use to the Congress in considering appropriation requests for the program.

EPA has worked with the Corps in the development and refinement of dredged-material disposal criteria, has coordinated with the Corps on various aspects of the DMRP, and is conducting its own research relative to dredging. EPA's direct participation in the DMRP, however, has been limited. USFWS has assigned a scientist to the DMRP to assist with research planning, development, and management.

Because EPA is the Federal Government's lead agency in environmental protection, we believe that EPA should assign a senior level individual to work on the final stages of the DMRP to assist in the interpretation of research results and the development of final conclusions for the 5-year research program. More importantly, we believe that if a follow-on program to the DMRP is developed, EPA should participate fully from the beginning by assigning staff to work full time on the initiation and conduct of the follow-on program. EPA's involvement in both the ongoing and proposed follow-on programs is particularly important because EPA is responsible for dredged-material disposal guidelines and criteria to which the research will apply.

Until the ongoing or follow-on research programs confirm or dispel the environmental risks of traditional disposal practices or develop new disposal alternatives, decisions will continue to be made on how to dispose of the material based on the best available scientific technology (oftentimes incomplete) and subjective evaluation. The choices of what to do in the meantime on any given project range from modifying existing practices to better protect against environmental damage to accepting the potential environmental risks of traditional dredging and disposal practices. Judgments between these choices depend on (1) quantifying the environmental risks and (2) knowing what the alternatives will cost. The DMRP should provide information which can be used in better quantifying the risks but the research has not been completed, and overall conclusions have not yet been drawn. The cost of alternatives (ranging from an estimated 100 to 1500 percent more than current costs for the projects we reviewed) have not been calculated on a nationwide basis.

Additional information, which could be of value in deciding among dredging and disposal alternatives, includes the range of methods for disposing of dredged material for each project, the environmental benefits or disbenefits of each method where known and identification of disagreements as to such benefits or disbenefits, and the estimated disposal costs associated with each method. Such information could be of value in future decisions regarding tradeoffs between environmental and economic values.

RECOMMENDATIONS TO THE SECRETARY OF  
THE ARMY AND THE ADMINISTRATOR,  
ENVIRONMENTAL PROTECTION AGENCY

We recommend that for those dredging projects where EPA objects to the method or location of the Corps' dredged-material disposal practices, the Corps, in coordination with EPA, should include in its budget justifications for those projects

- the estimated cost of proposed alternatives as compared to current costs,
- a description of the Corps' current and EPA's proposed disposal method or location,
- reasons for EPA's suggested change in disposal method or location including environmental benefits expected to be achieved or adverse effects expected to be avoided by the change, and
- the effect of the proposed change on the economic feasibility of the project.

We also recommend that EPA take a more active role in the Corps' dredging research by assigning staff to

- work full time on the final stages of the DMRP in interpreting research results and developing final conclusions for the program and
- participate fully, from the beginning, on the initiation and conduct of the proposed follow-on program to the DMRP if it is conducted.

In addition, we recommend that the Corps advise the Congress of the extent to which the anticipated follow-on research program to the DMRP could be expedited with additional personnel and funding.

AGENCY COMMENTS AND OUR EVALUATION

Regarding the recommendation on additional information in the Corps' budget justifications, the Department of the Army told us (see app. VI) that it believes that only those cases should be highlighted where significant cost increases occur due to environmental conditions. This approach, however, would not bring to the Congress' attention those cases where EPA objected to or questioned the Corps' practices, and changes were not made and additional funds were not requested.

We believe that the Congress should have the opportunity to participate in selecting between environmental and economic considerations in appropriating funds for controversial dredging projects. The information called for in our recommendation would provide the Congress a valuable tool for such participation and, consequently, we believe the additional information should be included in the Corps' budget justifications for each dredging project where EPA individually questions or objects to the Corps' practices. EPA did not specifically comment on this recommendation (see app. VII).

Concerning the recommendation relating to EPA's participation in the Corps' DMRP, the Department of the Army said that it agreed in principle with the recommendation but believed that the EPA/Corps Committee on Criteria Development was functioning effectively and was achieving coordination of research beyond the degree which any single person could achieve at this late stage of the research program. EPA did not specifically comment on this recommendation, but did note the EPA/Corps Committee has greatly improved coordination of EPA and Corps research over the past year.

We recognize that the Corps' research program is nearing completion (planned for March 1978), and coordination between the agencies has improved. Our recommendation, however, is made primarily to encourage EPA's participation in the research program as opposed to EPA's coordination with the program. We believe that EPA's participation in the final stages of the program would be valuable because

- interpretation of research results and development of final conclusions for the program will occur during this time period,
- EPA is responsible for dredged-material disposal guidelines and criteria to which the research results will apply,
- the universal acceptability and application of final research conclusions would be enhanced if the Federal Government's agency responsible for environmental protection participated in their preparation, and
- EPA's participation in the final stages of the existing program would give it a head start toward full participation in the proposed follow-on to the current research program if it is conducted.

We believe that the EPA/Corps joint Committee on Criteria Development, which meets only three times yearly, could be valuable, but is not an adequate substitute for EPA's direct,

full-time participation in the current and proposed follow-on research programs. It seems to us that the potential benefits of EPA's participation in both the current and proposed follow-on research programs far outweigh the costs to EPA of assigning personnel to participate in the programs.

Neither the Corps nor EPA commented specifically on our recommendations that (1) EPA take a more active role in the Corps' proposed follow-on research program and (2) the Corps advise Congress of the extent to which the proposed follow-on program can be expedited with additional personnel and funding.

CASE STUDYGREAT LAKES CONFINED DISPOSAL PROGRAM

The Great Lakes Confined Disposal Program, established in 1970, calls for placing behind retaining dikes any material dredged from the Great Lakes area which is determined by EPA to be polluted. This program is particularly important because it was the first major overall program dealing with the suspected environmental effects of dredged-material disposal. As a result, lessons learned in this program may be applicable in other locations where dredging and disposal changes are anticipated. The program to date has been characterized by substantial delays and cost increases.

BACKGROUND

In 1966 the Corps began a study of the effects of, and alternatives to, dumping dredged material from the Great Lakes harbors into the lakes. The study was initiated because of concerns that increased population and industrial development on the Great Lakes were causing the sediments in channels to become increasingly polluted.

In 1969, the Corps' Buffalo District issued a report on this study which stated that no harmful effects attributable to open water disposal had been identified, but that the possibility of environmental damage existed. The report concluded that in-lake disposal of heavily polluted dredged material must be considered presumptively undesirable, and that it might be desirable to construct diked areas to confine materials to be dredged over a 10-year period from 35 Great Lakes harbors which were considered highly polluted. The assumption was that after a 10-year period, sufficient progress would have been made under regulatory programs for controlling the entry of pollutants to permit a resumption of open water dumping without serious environmental risks.

The Congress responded to this recommendation by enacting section 123 of the River and Harbor Act of 1970. It authorized the Corps to build, operate, and maintain confined disposal facilities for polluted dredged material on the Great Lakes. The act also authorized EPA to advise the Corps as to which localities were in the greatest need of these facilities.

The legislation stated that local sponsors were to provide all necessary lands, easements, and rights-of-way for the proposed facilities, and were to contribute 25 percent of the construction costs of the facilities. The sponsors, however, could receive waivers of the local contribution if EPA found that the State or local interests were in compliance with an

approved plan for the general geographic area of the dredging activity for construction, modification, expansion, or rehabilitation of waste treatment facilities, and the Administrator of EPA found that applicable water quality standards were not being violated. As of February 1977, 46<sup>a/</sup> facilities were planned for the program and 32 have received waivers of the local contribution.

#### PROGRAM DELAYS

When the program was authorized in 1970, the Corps developed two plans for construction of the facilities--completion of the facilities in two construction seasons, or in four seasons. The Corps selected the latter plan because of anticipated lower costs. As of February 1977, 9 facilities had been completed, 5 were under construction, and 32<sup>a/</sup> had not been started.

The delays in program implementation have been primarily due to the involvement of other organizations, both public and private, in the site selection process. After a study of alternative locations for a confined facility, opinions are obtained from Federal, State, and local groups on the potential sites. Concurrence on the site finally chosen has to be obtained from the local government. An environmental impact statement must be prepared which entails contacts with many different organizations interested in the environmental implications of the project. In addition, before construction can begin, an agreement has to be consummated with the local sponsor on its responsibilities relative to the project.

For two harbors we reviewed--Conneaut and Huron, Ohio--45 and 36 months, respectively, were required from the date the confined disposal program was authorized by the Congress until the final preconstruction activities had been completed.

#### COSTS

When the program was authorized in 1970, the Corps estimated that it would cost between \$80 million and \$110 million to build the facilities depending on whether they would be completed in 4 or 2 years, respectively. As of February 1977, the total estimated cost of the program had increased to about \$263 million, as shown on the following chart.

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<sup>a/</sup>Includes five land disposal sites requiring very limited construction.

	<u>Number of sites</u>	<u>Estimated cost</u>
Completed	9	\$ 79,749,000
Under construction	5	94,000,000
Not yet started	<u>a/32</u>	<u>89,285,000</u>
Total	<u>46</u>	<u>\$263,034,000</u>

a/Includes five land disposal sites requiring very limited construction.

Several factors have contributed to the increased costs:

--Inflation.

--Initial estimates were based on the least costly sites, but local interests ultimately selected higher cost alternatives for many projects.

--Initial estimates based on general assumptions about site conditions and structural requirements were modified based on engineering studies.

In the Corps' Buffalo District, for example, least costly sites were rejected for 9 of 12 planned facilities, either because the site could not be acquired or because of State or local opposition to the least costly site.

In addition to the costs to construct the confined disposal facilities, operating costs for dredging and disposal activities have increased over open water disposal techniques because the material has to be transported greater distances to the confined areas.

In April 1977 the Corps estimated that costs per cubic yard for confined disposal on the Great Lakes as compared to open water disposal were as follows:

<u>Area</u>	<u>Confined disposal</u>	<u>Open lake</u>	<u>Percent increase</u>
Buffalo Harbor	\$5.63	\$1.10	412
Cleveland Harbor	7.39	2.00	270
Detroit River	5.61	1.10	410
Milwaukee Harbor	7.26	1.65	340
Average for all sites using confined disposal	\$6.77	\$1.49	354

An April 1977 Corps estimate for dredged material requiring confined disposal on the Great Lakes showed that total annual costs for maintaining these projects were \$58.6 million using confined disposal as opposed to \$12.9 million for open-water disposal.

CASE STUDYDREDGED-MATERIAL DISPOSAL IN THE NEW YORK BIGHT

The Port of New York handles more waterborne commerce than any other port in the United States--about 216 million tons yearly.

Most of the dredged material from the New York Harbor area is disposed of in an EPA-designated ocean disposal site in the New York Bight, about 6 miles off the New Jersey shore (see map on p. 41). This site has been used for the disposal of dredged material for over 30 years. Most of the material from New York Harbor contains high concentrations of nickel, lead, chromium, and cadmium. The Bight is also used as a dumping area for other materials, such as sewage sludge from many municipalities in the New York City area, excavation and demolition materials, and waste acids.

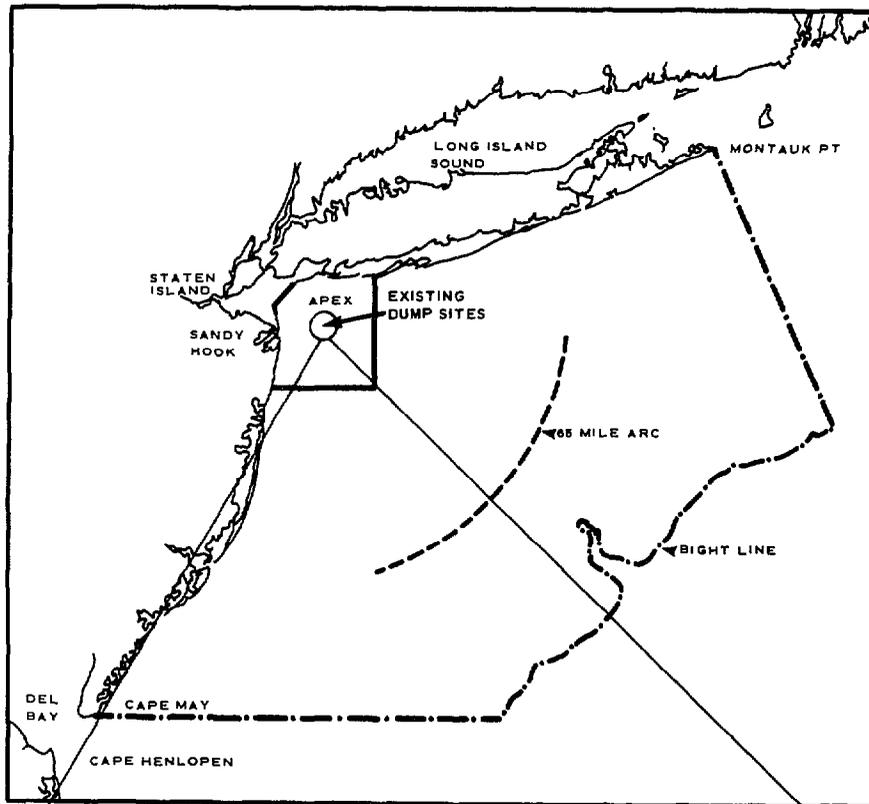
In October 1974 EPA announced its intention to move the dumping areas for sewage sludge further offshore after July 1976, and to phase out by 1981 the dumping of all sewage sludge and industrial wastes in favor of environmentally acceptable land-based alternatives. At the same time, EPA requested the Corps to submit a plan for phasing out the use of the existing dredged-material dump site by 1976 in favor of one further offshore.

EPA said that it took the action to counter a threat to the waters of New Jersey and Long Island from an expected threefold increase in the amount of sewage sludge generated by upgraded treatment facilities in the area. EPA explained its plan to move the dredged-material site on the basis that both sewage sludge and dredged material equally contribute to the actual load--pounds per year--of pollutants added to the ecosystem. As of April 1977, sewage sludge and industrial wastes were still being disposed of at the same location in the Bight with EPA's approval.

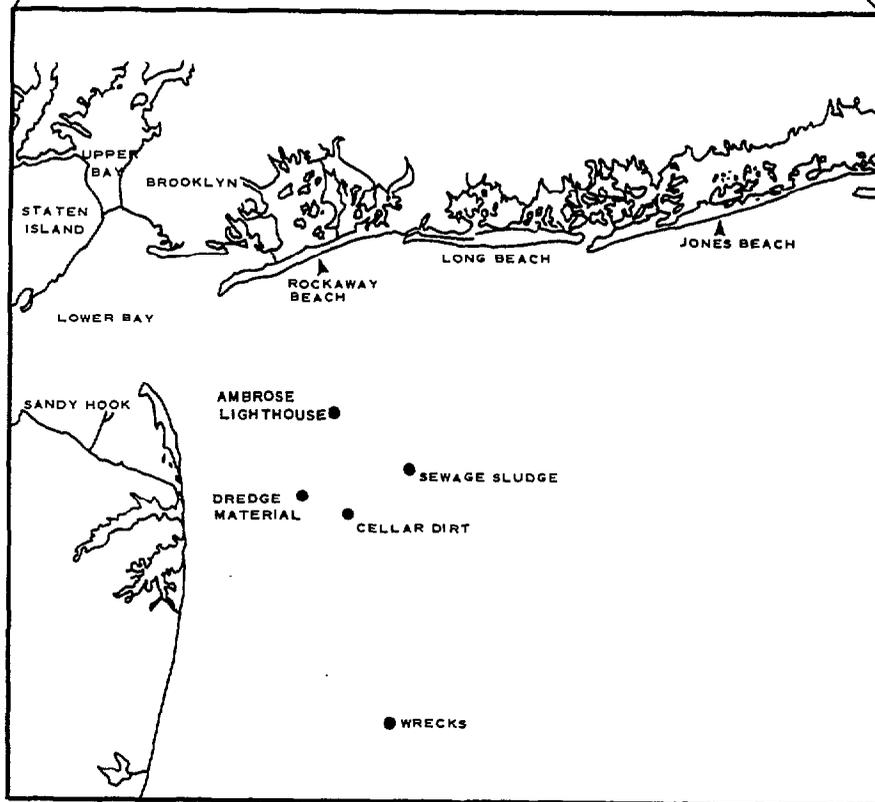
In July 1975 the Corps responded to EPA by stating that it had no evidence of adverse impacts from the disposal of dredged material at the present site on municipal water supplies, shellfish beds and fisheries, wildlife, or recreational areas, and that the Corps could not increase dredging costs by relocating the present disposal site without first knowing if there are adverse impacts from using the present procedure.

In a March 1975 report, NOAA reported that there was no evidence of imminent hazards to beaches and that the temporary use of a new site would likely result in more harm than good.

NEW YORK BIGHT



EXPLODED VIEW OF APEX SECTION



Because of future uncertainties about the Bight being available for dredged-material disposal, the Corps awarded a contract in April 1975 to an architect-engineering firm to study alternatives to the present site, such as the utilization of the alternative ocean disposal sites, or the creation of an artificial island in lower New York Bay, a confined disposal concept. The scope of the report required from the firm included the technical, economic, and environmental feasibility of the alternatives.

Preliminary estimates of the contract study indicated that moving the site 65 miles out to sea would increase annual costs from about \$25 million (\$2.67 per cubic yard) to about \$80 million (\$8.50 per cubic yard).

The Corps' New York District expects substantially increased costs under any plan that would ban the disposal of dredged material at the present site. The Corps' District solicited estimates from three private dredging firms on the cost increases that could be expected if the disposal site is moved to a location 65 miles away from the coast. The estimated increases ranged from 75 percent to 600 percent. One firm told the Corps that its fleet could not be converted to meet standards for towing 65 miles to sea. In view of the uncertain future of disposal in the Bight, the company felt that incentives to make investments in new or modified equipment would not be present unless Government guarantees or subsidies would be available.

As of January 1977, the Corps was still using the same ocean disposal site for dredged material as it has for the last 30 years, 6 miles off the New Jersey coast. EPA officials told us that the impacts of disposing dredged material at this site will be evaluated based on the new revised ocean disposal criteria of January 1977 to determine whether the use of this site should be continued or terminated.

CASE STUDYDISPOSAL OF MATERIAL DREDGED FROM THEUPPER MISSISSIPPI RIVER

The Corps' Upper Mississippi River navigation project extends from St. Louis, Missouri, to Minneapolis, Minnesota. The Corps' St. Paul District has jurisdiction over a 242-mile portion of the waterway extending from Guttenberg, Iowa, to St. Anthony Falls near Minneapolis, Minnesota. The Corps operates and maintains a 9-foot-deep navigation channel in the project area. Dredging operations in this area have been the subject of legal actions filed by the States of Wisconsin and Minnesota. The Minnesota legal action is discussed on pages 11 and 12.

WISCONSIN LEGAL ACTION

In June 1973, the State of Wisconsin initiated legal action in the United States District Court to obtain an injunction to prevent the Corps from disposing of dredged materials from a maintenance dredging project near La Crosse, Wisconsin. The State charged that the Corps had failed to file an environmental impact statement as required by the National Environmental Policy Act of 1969. The Court, after a hearing, granted a preliminary injunction in June 1973. This preliminary injunction was lifted in July 1973, when the Court noted that the State had not been able to show significant environmental damage resulting from dredged-material deposits at specific sites in Wisconsin.

In October 1973, the State, with more evidence, made a motion before the District Court for a preliminary injunction to enjoin and restrain the Corps from proceeding with its dredging disposal operations. In March 1974 the Court granted the injunction and ruled that the depositing of dredged materials within the State's boundaries was a major Federal action which had a significant effect on the quality of the environment and, therefore, before dredging could begin, the Corps was required to prepare, circulate, and file an environmental impact statement. In March 1975 the Corps filed the impact statement and the injunction was lifted in April 1975.

While the injunctions were in effect, the Corps was required to obtain the approval of the Wisconsin Department of Natural Resources for the selection of disposal sites; however, the Court allowed some emergency dredging. While the Corps normally dredged this area of the Mississippi

River to a depth of 13 feet, it was limited to 11 or 12 feet under the Court-imposed conditions. The Corps acknowledged that navigation was not impaired because of these constraints.

The Corps has since established a policy that no new maintenance dredging will be performed after January 1976 until an environmental impact statement has been prepared. The Corps expects to complete the preparation of almost all its environmental impact statements nationwide by the end of fiscal year 1977.

OPTIONS FOR FUTURE DREDGING  
AND DISPOSAL OPERATIONS

The Corps' environmental impact statement on the Upper Mississippi River presented various options to the existing maintenance practices. The alternative methods of disposing of dredged material were:

- Selective placement disposal in selected areas within the flood plain.
- Remote disposal, similar to selective placement, except that disposal sites would be larger and fewer.
- Central disposal, use of a single central disposal area within a specified section of the river.
- Removal from the flood plain, disposing of the material in upland areas.

The cost estimates for these methods were:

<u>Method of disposal</u>	<u>Total average annual cost</u>	<u>Unit cost per cubic yard</u>	<u>Percent increase</u>
Traditional method	\$ 740,000	\$ .50	--
Selective placement	3,670,000	2.45	390
Remote disposal	5,260,000	3.50	600
Central disposal	8,950,000	5.95	1090
Removal from floodplain	8,120,000	5.40	980

Of these options, the Corps chose the selective placement method rather than the traditional method since it believed

selective placement was environmentally acceptable and economically feasible; and phased in the selective placement method during 1974-76.

GREAT RIVER ENVIRONMENTAL  
ACTION TEAM (GREAT)

The Corps' environmental impact statement on the Upper Mississippi River recommended that a comprehensive 2-year study of the environmental problems associated with channel maintenance on the Upper Mississippi River be undertaken. Under the sponsorship of the Upper Mississippi River Basin Commission, a study group was formed in October 1974, which subsequently led to GREAT. /

The ultimate goal of the study is to develop a river system management plan for the Upper Mississippi River that would incorporate total river resource requirements, including commercial navigation, fish and wildlife resources, and recreation.

Federal agencies represented on GREAT are the Corps, USFWS, EPA, and the Soil Conservation Service of the Department of Agriculture. Representatives from the States of Minnesota, Wisconsin, and Iowa are also members of GREAT. All members of the team participate in work-study groups and leadership responsibilities are divided among the agencies. Representatives of citizen groups are also invited to review study findings and provide nontechnical information.

GREAT is also involved in on-site inspections of potential Corps dredged-disposal sites to minimize environmentally harmful disposal of dredged material and better determine the environmental effects of its disposal. Upon completion of the Corps' dredging activities for the 1975 season, GREAT began an analysis of the environmental and economic benefits achieved in areas where GREAT recommendations were considered.

Through the uses of town meetings and study reviews by broad-based citizen groups, GREAT is able to keep the river community aware of its recommendations and activities.

CASE STUDY  
DREDGED-MATERIAL DISPOSAL IN THE  
SAN FRANCISCO BAY AREA

The San Francisco Bay area is a mixing area for the waters of the Sacramento-San Joaquin River systems and the tidal waters of the Pacific Ocean. It includes San Francisco Bay, Suisun Bay, San Pablo Bay, Central Bay, and South Bay (see map on p. 47). The Bay area is the largest port complex on the Pacific Coast, including such important ports as San Francisco, Oakland, Richmond, and Stockton; and strategic military bases at Alameda and Mare Island.

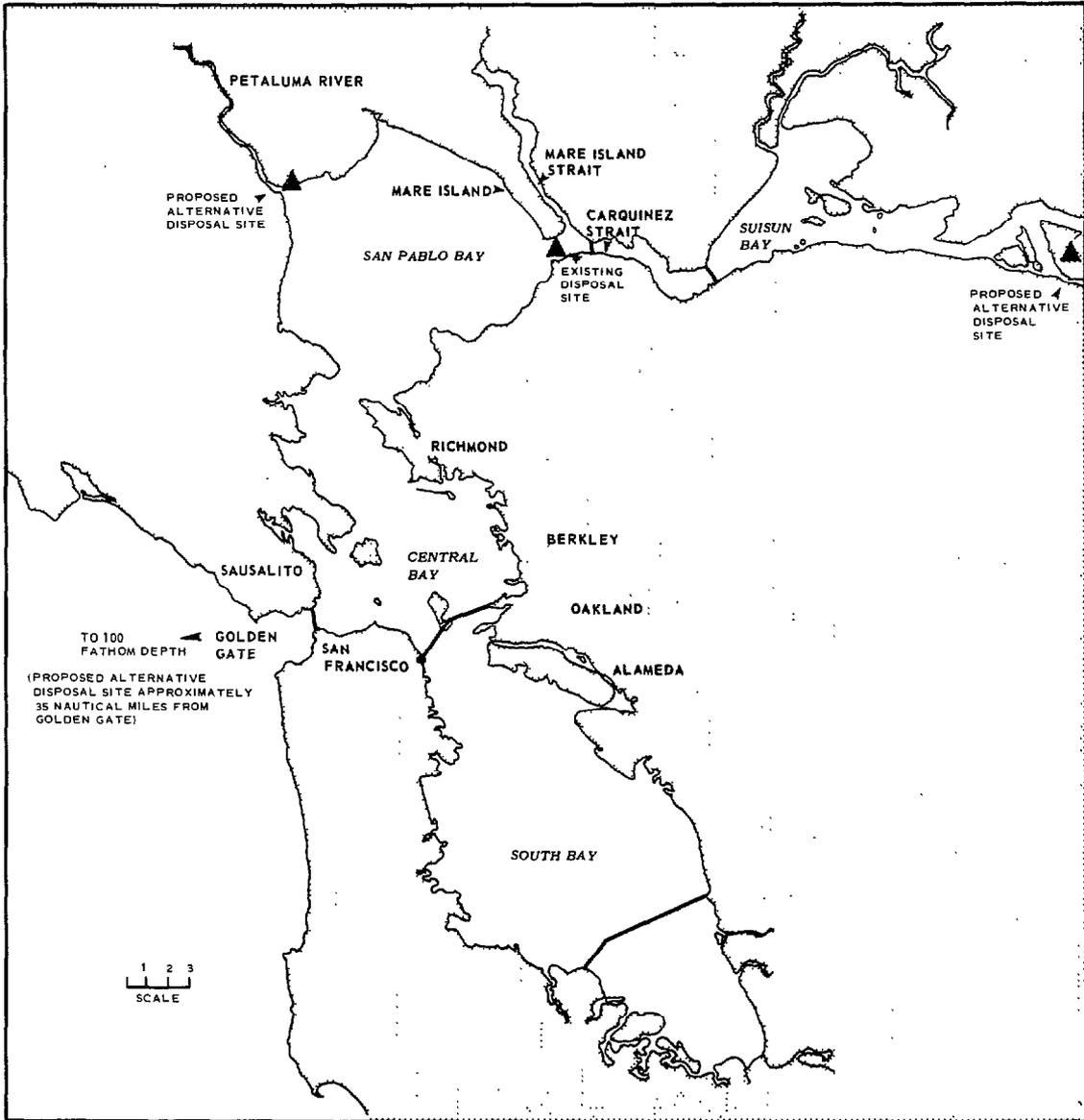
The economy of the San Francisco Bay area is dependent on the shipping industry, which transports about 60 million tons of general cargo into and out of the Bay area annually. Foreign trade accounts for about 25 percent of this tonnage, with petroleum products representing 70 percent of all tonnage. Corps officials told us that they are responsible for about 55 percent or 5.7 million cubic yards of all material dredged annually from the Bay. Approximately 75 percent of the material dredged by the Corps is disposed of in the Bay area. The remainder is currently disposed of in open water, but has been proposed for land disposal at sites adjacent to or within a few miles of the dredge operation.

BAY POLLUTANTS

Pollutants enter the Bay system from municipal sewage, industrial waste outfalls, storm drains, surface runoff, aerial fallout, discharge from vessels, agricultural drainage and upland erosion, and leaching from waste disposal sites adjacent to the Bay and tributary waters. Although improved over the last few years, the Bay still contains substantial amounts of pollutants. About 40 percent of the municipal sewage entering the Bay receives secondary treatment and the other 60 percent receives only primary treatment.

Environmental agencies in the Bay area, including USFWS, have said that much of the dredged material should be disposed of on land or at deep ocean disposal sites (100-fathom depth). Corps officials in the San Francisco District told us that they believe open water disposal creates far less water pollution than is created by waste treatment plants, industry, and natural processes such as storm runoffs, and that it is much more important to treat the causes rather than the effects of pollution.

SAN FRANCISCO BAY SYSTEM



An example of the issues being faced in the San Francisco Bay area follows.

#### MARE ISLAND STRAIT PROJECT

Two-and-a-half million cubic yards of material are dredged from the Mare Island Strait project annually. Corps officials told us this represents about 43 percent of the Corps' annual maintenance dredging in the Bay.

The project involves dredging a 30- to 45-foot-deep channel in San Pablo Bay, Mare Island Strait, and the mouth of Carquinez Strait. The Mare Island channel portion is used by nuclear submarines and other deep-draft naval vessels moving to and from the Mare Island Naval Shipyard. Carquinez Strait, an EPA-approved disposal site, has been used as the disposal site for the dredged material.

EPA and USFWS consider the Mare Island Strait project to be the most environmentally sensitive maintenance dredging project in the Bay area, and the Carquinez Strait disposal site to be the least environmentally desirable. Mare Island and Carquinez Straits are corridors for anadromous fish (ocean fish which return to fresh water to spawn). Several species--chinook, steelhead, and sturgeon--pass through these straits in their annual spawning migrations.

The Corps performed a tracer study on the dispersion of dredged material dumped at this site as part of its San Francisco dredged disposal study. The tracer study was conducted in North San Francisco Bay to determine the long-term dispersion, deposition, and circulation of sediments dredged from Mare Island Strait and dumped at the Carquinez disposal site. The study showed that

--the dispersion of dredge material after disposal was very rapid and

--dredged material was found dispersed over 100 square miles.

Additionally, the Corps told us that between 10 to 15 percent of the quantity discharged at the disposal site returns to the dredged channel.

In a July 1975 letter to the Corps' San Francisco District, the Department of the Interior noted that concern about the suspected physical, chemical, and biological impacts of dredging and disposal on anadromous fish passing through the Carquinez Strait dredge spoil disposal site had caused State and Federal

biologists to request that the site be used only during the months of December, January, and February when the fish are present in lower numbers. Due to a high shoaling rate in the Mare Island Strait, the Corps has stated that it is necessary to dredge on a semi-annual basis, from September through November, and from February through April.

In January 1975, USFWS suggested the construction of a disposal pipeline to an island located about 20 miles from the dredging site or to the 100-fathom depth of the ocean to alleviate the Bay disposal problems. As interim measures, USFWS said that it would prefer the use of the Navy's Mare Island land disposal site (capable of handling only about 3 million cubic yards of material) or a new aquatic site several miles to the west of the present Carquinez Strait site. The Corps' District Engineer maintained that, besides being more expensive, transferring the dredged material to another aquatic disposal site in the Bay could increase shoaling in another location.

The San Francisco Bay Conservation and Development Commission, a regional planning agency established to protect the Bay, had suggested that disposal of dredged material should be on dry land, in approved fill projects, in the ocean, or-- as a last alternative--at designated Bay disposal sites.

As of April 1977, Corps' officials told us that the Carquinez Strait was still being used as the disposal site for dredged material from the Mare Island Strait project.

The Corps estimated that the disposal costs for the Mare Island Strait project would increase substantially if it had to change from the Carquinez Strait disposal site to more environmentally acceptable sites. The following table shows Corps estimates, prepared in September 1974, based on the removal of 1.8 million cubic yards annually in the Mare Island Strait project.

<u>Disposal site</u>	<u>Cost per cubic yard</u>	<u>Approximate total annual cost</u>	<u>Percentage increase</u>
Carquinez Strait (current site)	\$ .25	\$ 450,000	--
Petaluma (land)	2.72	4,896,000	988
100 Fathoms (ocean)	2.97	5,346,000	1,088

SAN FRANCISCO BAY STUDY

A dredged disposal study for the San Francisco Bay and Estuary was conducted to complement the Corps' DMRP (see ch. 6). The study was initiated in April 1972 and the main report was published in February 1977.

The purpose of the Bay study was to provide definitive information on the environmental impact of dredging and dredge spoil disposal in the San Francisco Bay. The study's scope was divided into the following three categories:

- Dredging with aquatic disposal within the Bay.
- Alternative disposal methods.
- Dredging technology.

The Corps conducted the study in cooperation with EPA, USFWS, the National Marine Fisheries Service, State and local agencies, and consultants. The cost of the study was about \$3 million.

Some of the conclusions of the study were:

- Although large changes in water quality were demonstrated, no analogous changes in organisms were observed.
- Release of toxicants during dredging and disposal operations seems to be at such low levels and to last for such short durations that their availability for uptake and accumulation is extremely limited.
- Open water disposal is not considered a significant blockage of the channels for migration of fish, particularly through Carquinez Strait.
- The transport of highly contaminated sediments from the Bay to deep water ocean disposal sites has the potential for creating long-term biological impact.
- Extensive land disposal for maintenance dredging projects does not appear to be a viable alternative to aquatic disposal at this time because of costs, identified technical difficulties, and adverse environmental effects which may be involved.

CASE STUDYDISPOSAL OF DREDGED MATERIALAT SELECTED GULF OF MEXICO HARBORSMOBILE HARBOR

Mobile Harbor, Alabama, contains about 42 miles of navigable channels. To maintain these channels at the authorized 40-foot depth requires the removal of an average of 7.5 million cubic yards of sediment each year at an average cost of \$.21 per cubic yard. Material dredged from the bar channel leading into the Gulf of Mexico is deposited by hopper dredge into the open water in the Gulf. Material dredged in the Mobile Bay channel is deposited by hydraulic pipeline on either side of the channel. Material from the river portion of the channel has for a number of years been confined by dikes. The Corps' Mobile District long-range disposal plan had called for the continued use of these disposal practices.

In response to the Corps District's draft environmental impact statement dated July 25, 1974, which described these plans, EPA and the Department of the Interior objected to the planned enlargement of the existing diked areas and recommended that alternate methods be sought for the disposal of material now disposed of in the Bay.

The project's local sponsor, the Alabama State Docks Department, proposed two alternate disposal sites: Blakely Island and Pinto Island. These proposed sites were approved by EPA but Mobile County expressed reluctance to use them until more alternatives were considered. The alternative disposal sites would increase the cost of dredging the river channel from about \$.81 per cubic yard for the long-range plan to between \$1.34 and \$2.00 per cubic yard for the alternatives, increases of from 65 to 147 percent.

The Corps' Mobile District developed three alternative plans for disposing of material dredged from the Bay: (1) alongside the ship channel, (2) on islands constructed in the Gulf, and (3) in diked islands along the Gulf shore. According to EPA, the capacity of the proposed land sites will be reached in 12 years, and as a result, the Corps will be faced with the recurring problem of selecting suitable land disposal sites.

In its long-range plan, the Corps District planned to continue dumping material dredged from the Bay channel into the open waters of the Bay. District officials said that the cost of confining the material in dikes or of transporting it

to the Gulf for disposal would be prohibitive, but they had not prepared cost estimates of the economic implications of the suggested changes.

#### GULFPORT HARBOR, MISSISSIPPI

The authorized Gulfport project provides for a channel 19 miles long, with varying depths, from the Gulf of Mexico to the Gulfport Harbor facilities. Dredging is usually performed annually. An annual average of 2,930,000 cubic yards is hydraulically dredged and 910,000 cubic yards were hopper-dredged. The material is deposited along the ship channel and in the Gulf.

In its May 1973 draft environmental impact statement on the Gulfport Harbor, the Corps stated that, due to the 25-mile distance to the nearest upland areas suitable for dredged spoil disposal, it did not consider alternatives and would continue present dredge and disposal methods. EPA objected, stating that continued use of the existing sites would eventually restrict or alter circulation patterns with a resultant degradation in water quality. As a result, EPA suggested that the Corps give consideration to placing the material on upland areas and in Gulf water areas deeper than the ones normally used.

The Corps estimated that if the suggested actions were implemented, the effect on the project's benefits and costs would be as follows:

<u>Method</u>	<u>Estimated annual benefits</u>	<u>Estimated annual costs</u>	<u>Benefit-to-cost ratio</u>
Open water	\$2,026,900	\$ 679,534	2.98
Diked upland areas	2,026,900	9,000,000	.23
Ocean disposal	2,026,900	11,000,000	.18

The high costs for the alternate plans were due to the unavailability of suitable land in close proximity to the ship channel and the need for additional equipment to dredge and transport the material to the Gulf. Unless required to do otherwise, the Corps plans to continue its traditional method of dredging and disposing in the open water since the other methods would be economically prohibitive.



DEPARTMENT OF THE ARMY  
 OFFICE OF THE ASSISTANT SECRETARY  
 WASHINGTON, D.C. 20310

28 FEB 1977

Mr. Henry Eschwege  
 Director, Community and Economic  
 Development Division  
 General Accounting Office  
 Washington, D.C. 20548

Dear Mr. Eschwege:

This is in reply to your letter of 7 December 1976 to the Secretary of Defense forwarding copies of your draft report, "Dredging America's Waterways and Harbors--More Information Needed on Environmental and Economic Issues," OSD Case #4488.

Representatives of GAO and Corps of Engineers have met and discussed a number of recommended proposed changes to the draft report. Most of our suggestions, many of which were updating information, were agreed to by your auditors.

As a general observation we agree in principle with the recommendation made on pages iv and 38 of assigning an EPA staff member to work full time on the DMRP. However, we do feel that the EPA/CE Committee on Criteria Development is functioning effectively and achieving coordination of research and planning to a degree beyond which any single person could effect by being assigned to the program at this late stage.

The recommendation on pages v and 38 suggests that when EPA objects to the method or location of the Corps dredged material disposal operations, the Corps should include certain information in its budget justifications for those projects. We believe this recommendation should be modified to properly reflect the consultation and coordination responsibilities of both EPA and the Corps to jointly solve environmental problems. We should only highlight those cases in which significant cost increases occur due to environmental conditions. This suggestion can be accomplished by changing the last sentence on page v to read: "GAO recommends that the Corps, in conjunction with EPA, prepare and provide such information to Congress, on those individual dredging projects where there has been a change in method or location of the Corps dredging



and disposal operations for environmental reasons resulting in significant cost increases," (See page 38). Appropriate changes should also be made to the recommendations on page 38.

We are inclosing several specific recommended changes to the report to more appropriately reflect our views.

We appreciate the opportunity to review the draft report and for our representatives to discuss in detail its salient points.

Sincerely,



1 Incl  
as

Charles R. Ford  
Acting Assistant Secretary of the Army  
(Civil Works)

**GAO note:** The inlusure mentioned above is not included in the report, but was considered by us in preparing this report.

**Note:** Page references in this appendix refer to our draft report and may not correspond to the pages of this final report.



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY  
WASHINGTON, D.C. 20460

MAR 24 1977

OFFICE OF  
PLANNING AND MANAGEMENT

Mr. Henry Eschwege, Director  
Community and Economic Development Division  
United States General Accounting Office  
Washington, D. C. 20548

Dear Mr. Eschwege:

We have reviewed the draft report entitled "Dredging America's Waterways and Harbors - More Information Needed on Environmental and Economic Issues." We appreciated the opportunity to work with the General Accounting Office auditors in reviewing the draft and are pleased to find that many improvements suggested have been incorporated into the report.

We agree with the general premise of the report that more information is needed on the environmental and economic issues associated with the dredging of America's waterways and harbors. As was brought out in our discussions, the environmental and economic issues of dredging America's waterways and harbors are very complex and are extremely difficult to communicate simply and in a brief report. At the risk of calling factors to your attention that have already been included in the final version, we think the following concepts are significant and worth summarizing.

1. Adverse physical effects of dredged material disposal, as differentiated from effects of contaminated material, are quite important.
2. Degradation and destruction of the natural environment often result in short- and long-term economic costs to society that greatly exceed the short-term increase in dredging costs.

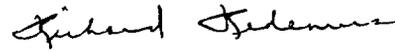
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3. Traditional disposal practices sometimes include dumping material near the dredging site where material often returns to the channel or harbor necessitating the extra expense and associated potential environmental damage of redredging.
4. Modern dredging equipment can greatly reduce the unit cost of disposing of dredged material and minimize the environmental and economic consequences mentioned above. As of this time, modern dredging equipment is not widely available in the United States. (See attachment)
5. There is a strong interrelationship between navigation and other national interests such as flood plain management and water quality protection.
6. Environmental legislation and legislation authorizing channel and harbor maintenance, its scope and date of enactment are controlling factors that should be examined thoroughly and placed in perspective.
7. The Corps/EPA Joint Research Committee has greatly improved coordination of EPA and Corps research effort over the past year.
8. Final revisions to the Ocean Dumping Regulations and Criteria were published in the Federal Register on January 11, 1977, and significantly update the criteria for evaluating dredged material proposed for ocean disposal. The revisions further provide procedures for the selection and management of ocean disposal sites, including criteria for evaluating dumping impact to determine whether individual sites should be designated for continuing use or whether use of such sites should be terminated.
9. The Corps should be funded to construct, operate, and maintain navigational projects in an environmentally acceptable manner and to deal with contingencies that increase maintenance costs, such as the Kepone contamination of the James River.

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We appreciate the opportunity to review this draft report prior to its submission to Congress. Please contact us if we can be of any further assistance.

Sincerely yours,



Richard Redenius  
Acting Assistant Administrator  
for Planning and Management

Enclosure

## ATTACHMENT

Examples of the Need for Advanced Dredging Technology

In many projects it is now recognized that if disposal sites can be located outside the immediate vicinity of the harbor or channel, one or more of the following benefits can be achieved:

- (1) the amount of dredged material that returns to the channel can be reduced, thereby minimizing the frequency and cost of maintenance dredging;
- (2) material can be used to stabilize eroding beaches;
- (3) destruction or degradation of important aquatic systems can be avoided.

Unfortunately, most equipment now in use in the United States is not designed for cost effective removal and transportation of dredged material.

Investment in more modern dredging technology can reduce costs and at the same time, better protect the aquatic environment. Many dredging systems now operating in U.S. waters are extracting only 15 to 20 percent solids and the systems cannot readily concentrate the fine clayey silts found in most harbors and channels for efficient transport to suitable disposal areas. Thus, much of the cost of transporting material to disposal sites results from hauling loads that contain a large percentage of water. For example, a hopper dredge can be inefficient because it is not pumping sediment while

it is transporting spoil to the disposal site and because it has no means for concentrating fine clayey silts. A conventional pipe line dredge with a single barge is also inefficient because its pump does not concentrate the solids and it is not operating while the single barge is transporting the spoil. Although the conventional pipeline dredge action in conjunction with a fleet of barges would be more efficient than the single barge, it is still inefficient when handling the fine clayey silts because these materials cannot be readily concentrated.

The basic equipment is available on the market today for dredging and transporting materials from 15 to 20 miles or more at a reasonable cost. Chain bucket dredges which concentrate the solids by simply letting the water fall off when the bucket is full have been used for years in Europe. A report by Adolph W. Mohr, MASCE of the Corps of Engineers, South Atlantic Division states that the chain bucket dredge takes less power to operate and is more efficient than the conventional pipeline dredge used in this country.

Pumps capable of concentrating clayey silts have already been tested by the Corps of Engineers, Philadelphia District. If the suction head on a hydraulic dredge is

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reduced by lowering it into the water on a dredging arm it can be made to pump spoil with a high concentration of solids. Pneumatic pumps are also available which can handle spoil with a high solids content. The system designed by the Philadelphia District of the Corps of Engineers consists of a special dredge of catamaran design with its own propulsion system with dredge heads and pumps designed to give high solids to water ratios. The system is designed to operate continuously as it includes sufficient bottom unloading barges to insure continual loading and transport of spoil to remote disposal sites without shut down of the pumps. The system is described in the "Long Range Spoil Disposal Study, Part IV, Substudy 3, Development of New Dredging Equipment and Techniques" U.S. Army Corps of Engineers, Philadelphia, Pennsylvania. It has been demonstrated that this equipment can pump fine clayey silt materials at a rate of 7,000,000 cubic yards of insitu materials to 11,600,000 cubic yards of dredged mixture in 7,000 hours (28 cu yd/min.). The average density of the shoal material was 1,300 gr/l. This equipment was investigated for the Charleston Harbor project and was found to be the most economical method of eight (8) alternatives studied by the Corps of Engineers. EPA has recommended this method for use at Gulfport, Mobile, Pascagoula, Charleston,

and Savannah Harbors and it could be used at most of our large harbors because most of them have similar spoil disposal problems.

The main problem seems to be the initial cost of the equipment, and private investors are not willing to invest in the equipment unless they can be assured of a sufficient number of contracts to pay for the equipment and show a profit. However, where the cost was prorated to only one job such as at Charleston Harbor the cost was 42¢ per cubic yard as compared with \$2.64 for hopper dredging the same material (1970 prices) or about 1/6 the cost of hopper dredging. If the cost of this equipment could be prorated to several jobs such as Gulfport, Pascagoula, Mobile, Panama City, and Pensacola Harbors on the Gulf Coast and another system to Charleston, Georgetown, Wilmington, Savannah, Brunswick, and Jacksonville Harbors on the Atlantic Coast, the cost per cubic yard could be greatly reduced. Although the knowledge of the advantages of this system has been available since 1969-1970, little progress has been made with regard to implementing the use of such a system.

There is also a need for additional similar equipment smaller in size but with pumpout facilities for use along the Intracoastal Waterways and at small boat harbors. Silt and sandbars have to be removed from the waterways and side channels at frequent intervals for proper maintenance. Since the waterways travel through marshes and valuable shallow water bays and estuaries, suitable spoil sites are frequently beyond economic pumping distance. Moreover, since beach erosion problems exist along most of the Atlantic and Gulf Coast shores, much of the sandy shoal material could be used to good advantage on the beaches. Where the beach is beyond the economic pumping distance of a conventional pipeline dredge, bottom unloading barges with pumpout facilities which can pump to the beach or the dune areas or bottom unload along the beach would be of exceptional value. The Wilmington District of the Corps of Engineers has experimented with this approach using the split hull, bottom dumping barge, the Currituck. Similar barges could be used for pumping the clayey silt materials to upland diked areas or for disposal at ocean sites.

Thus, the continued use of out-dated dredging equipment has artificially inflated the cost of economically sound disposal practices that also would minimize adverse effects on the aquatic environment.

PRINCIPAL OFFICIALS RESPONSIBLE  
FOR ACTIVITIES DISCUSSED IN THIS REPORT

Tenure of office  
From                      To

DEPARTMENT OF DEFENSE

SECRETARY OF DEFENSE:

Harold Brown	Jan. 1977	Present
Donald H. Rumsfeld	Nov. 1975	Jan. 1977
James Schlesinger	June 1973	Nov. 1975
William P. Clements, Jr. (acting)	May 1973	June 1973
Elliott L. Richardson	Jan. 1973	Apr. 1973
Melvin Laird	Jan. 1969	Jan. 1973

DEPARTMENT OF THE ARMY

SECRETARY OF THE ARMY:

Clifford L. Alexander	Feb. 1977	Present
Martin R. Hoffman	Aug. 1975	Feb. 1977
Howard H. Calloway	May 1973	July 1975
Robert F. Froehlke	July 1971	May 1973
Stanley R. Resor	July 1965	June 1971

ASSISTANT SECRETARY OF THE ARMY  
FOR CIVIL WORKS:

Charles R. Ford (acting)	Feb. 1977	Present
Victor V. Veysey	Mar. 1975	Jan. 1977

CHIEF OF ENGINEERS:

Lt. Gen. John W. Morris	July 1976	Present
Lt. Gen. William C. Gribble, Jr.	Aug. 1973	June 1976
Lt. Gen. Frederick J. Clarke	Aug. 1969	July 1973

ENVIRONMENTAL PROTECTION AGENCY

ADMINISTRATOR:

Douglas M. Costle	Feb. 1977	Present
Russell E. Train	Sept. 1973	Jan. 1977
John R. Quarles, Jr. (acting)	Aug. 1973	Sept. 1973
Robert W. Fri (acting)	Apr. 1973	Aug. 1973
William D. Ruckelshaus	Dec. 1970	Apr. 1973

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